BMJ Open

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Journal:	*BMJ Open*
Manuscript ID	bmjopen-2020-039177
Article Type:	Original research
Date Submitted by the Author:	08-Apr-2020
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Keywords:	HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Health policy < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Public health < INFECTIOUS DISEASES

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Separate Fever Clinics Prevent the Spread of COVID-19 and Offload Emergency Resources: Analysis from a large tertiary hospital in China

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Word count for the text ：2510

Funding：This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Abstract

objectives: COVID-19 began spreading widely in China in January 2020. Outpatient "Fever Clinics" (FCs), instituted during the SARS epidemic in 2003 were upgraded to provide COVID-19 screening and prevention attached to large tertiary hospitals. We sought to analyze the effect of upgraded FCs to detecting COVID-19 at our institution.

Design：A population-based cross-sectional study.

Participants：A total of 6,365 patients were screened in the FC.

Methods: The FC of Peking Union Medical College Hospital (PUMCH) was upgraded on January 20, 2020. We performed a retrospective study of patients presenting to the FC between December 12, 2019 to February 29, 2020, covering a period of 40 days before and after upgrading the FC. All necessary data, including baseline patient information, diagnoses, follow-up conditions for critical patients, transfer information between the FC and emergency department (ED) were collected and analyzed.

Results: 6,365 patients were screened in the FC, among whom 2,192 patients were screened before January 21, 2020, while 3,453 were screened afterwards. Screening results showed that upper respiratory infection was the major disease associated with fever. Compared to before the outbreak, patients transferred from the FC to ED decreased significantly [39.21% vs 15.75%, p<0.001] and tended to spend more time in the FC [55 vs 203mins, p<0.001]. For critically-ill patients waiting for a screening result, the total length of stay in the FC was 22mins before the outbreak, compared to 442mins after the outbreak (p< 0.001). The number of in-hospital deaths of critical-care patients seen first in the FC was 9 of 29 patients before the outbreak and 21 of 38 after (p<0.050). Nineteen COVID-19 cases were confirmed in the FC, but no other patients or medical care providers were cross-infected.

Conclusion: The work-load of the FC increased after the COVID-19 outbreak and effectively prevented COVID-19 from spreading in the hospital，as well as offload ED resources**.**

Key words: COVID-19 outbreak, fever clinic, emergency department, disease screening, disease prevention

Introduction

Background

Coronavirus disease 2019 (COVID-19) caused by the severe acute respiratory syndrome coronavirus 2 (SARS-COV-2) broke out in Wuhan, Hubei Province at the end of 2019[1], and cases are now rapidly spreading worldwide [2] . Currently, controlling the spread of SARS-CoV-2 is of primary concern [3]. The main manifestations of this disease include acute fever, cough and dyspnea [4], thus emergency departments (EDs) have become the primary facilities providing

initial diagnoses and medical care for potential COVID-19 patients. Unfortunately, as the virus spreads widely, crowded patients in EDs face a high risk of cross-infection [5,6]. In mainland China, outpatient "fever clinics" (FCs), affiliated to the ED, are designed to help separate potentially infectious from non-infectious patients [7]. FCs were started at the suggestion of National Health Commission of the People's Republic of China as early as 2003 during the SARS outbreak in China Even after the SARS event, FCs were still preserved as a location near EDs for early identification and isolation of potentially infectious patients [8]. Therefore, few suspected patients were managed in emergency department[9]. However, between SARS in 2003 and the current COVID-19 outbreak, the FC system has seen few similar stresses and few reports have emerged about this potentially key element of hospital infection-prevention infrastructure.

FC upgrade after the COVID-19 outbreak

Before the COVID-19 outbreak, four doctors were allocated to the FC where influenza A and B were screened for every patient suffering from both fever and respiratory symptoms. The FC was also tasked with excluding eruptive infectious diseases (e.g. measles, rubella, and varicella). Patients with infectious diseases received initial therapy in the FC, and then were transferred to inpatient isolation wards if needed; other patients were transferred to the ED. After the COVID-19 outbreak, as many as twelve doctors wearing "grade-3" isolation gowns worked in the FC[10]. Two consulting rooms were added to supplement the original single-room. The number of medical care providers providing in-person coverage every 24 hours increased from two to nine every 24 hours, while nursing staff increased from nine to 15 every 24 hours. Rescue equipment such as endotracheal intubation tools, central venous catheters, noninvasive and invasive ventilator machines, high-flow oxygen therapy devices and bedside ultrasound were added or expanded.

All patients with either fever or respiratory symptoms, no matter with or without a history of Covid-19 exposure, were mandated to go through FC triage (see Figure 1). Each patient was required to wear a mask on arrival to the FC and was allocated to different regions according to their triage history and clinical severity (see Figure 1). FC took responsibility for screening SARS-COV-2, in addition to influenza and eruptive diseases noted above. All acquired nucleic acid samples were tested by two independent laboratories that had been authorized by the Beijing Municipal Health Commission. Only "double negative" results was defined as a negative result for the patient. In addition to identification, there were specialized doctors in charge of suspected patients, critical patients and common patients, respectively. Negative pressure isolation wards with complete sets of resuscitation equipment were readied for any critical patients. Once the screening tests were reported, confirmed patients would be transferred to specialized hospitals whereas others who needed further treatment were transferred into the ED (see Figure 2).

Methods

Data collection

We collected data from all patients who presented to the FC of PUMCH 40 days before the upgrade in the FC (December 12, 2019 to January 20, 2020), and for 40 days after the upgrade from January 21 to February 29, 2020. The FC upgrade date (January 20, 2020) was also the

official date Covid-19 was declared an "outbreak" in Beijing. We included all critically ill patients during this period who presented to the FC and then were transferred to the ED. The data were collected from patients' medical records and their registration information at the time of presentation. Patients' clinical condition, primary diagnoses, time of registration (FC and, potentially, ED), as well as the duration of consultation at each visit were obtained.

Critically ill patients were identified according to the following criteria: (1) patients transferred to resuscitation rooms in the ED from the FC after initial screening and initial treatment; (2) APACHE II score ≥8; (3) patients who were ruled out the possibility of COVID-19 pneumonia[11]. Critically ill patients' prognoses and treatment results were documented by medical records, as well as any changes in patients' condition within seven days following initial presentation to the FC (improvement, non-improvement or death).

Patient and Public Involvement

This was a restrospective study,we collected medical information of all involved patients from electronic information system.The patients did not involve in the recruitment to and conduct of the study, as well as not join in designing.

Statistics

Statistical Package for Social Sciences 24.0 software (IBM Corp., Aramonk, NY, USA) was used for statistical analysis. The Kolmogorov-Smirnov test was used to determine the normal distribution of variables. Variables with normal distribution are shown as a mean (±SD). T-tests were used for variables that followed normal distribution.. Data that did not follow normal distribution was shown as a median (25%-75%) and analyzed by the Wilcoxon rank sum test. Chi-square tests and Fisher's exact tests were used for enumeration data. P-values less than 0.05 were taken to indicate statistical significance.

Results

Patient Characteristics and Disease Etiologies

In total, 6,365 patients were screened in the FC, among whom 2,192 patients were screened before the outbreak, and 3,453 patients were screened after the outbreak was declared and the FC upgraded on January 20, 2020. There was no statistical difference in sex ratio between the two groups, but a significant difference in age was seen (p=0.001). The most common disease found in the FC was an upper respiratory infection, followed by an abdomino-pelvic infection and pneumonia (see Table 1).

FC to ED transfer statistics before and after the COVID-19 outbreak

The number of registered patients who presented first to the FC and were then transferred to the ED before and after the outbreak was 1,142 and 544, respectively. There was no statistical difference in the sex ratio or age of patients between these two groups (p>0.05). 1,083 (94.84%) of cases before the outbreak took less than 24 hours to transfer between the FC and ED. After the outbreak, 482 cases met this benchmark (p<0.001). Meanwhile, the treatment time in the FC grew significantly longer compared to before the outbreak (p<0.001) (see Table 2).

Critically ill patients

69 critically ill patients were included in our analysis, and two patients were excluded due to an APACHE II score < 8 points. 29 and 38 patients presented, respectively, at the FC before and after the COVID-19 outbreak. The ratio of male to female patients was 1.23:1, average age was 61 (44,76). There was no significant difference in the sex ratio or age of patients between the two groups ($p>0.05$). There was also no significant difference in the severity of disease between the two groups when examining the respective APACHE II scores (16.1±6.67 vs 18.74±6.72 ($p>0.05$). Patients with septic shock and pneumonia combined with respiratory failure accounted for most diagnoses. The number of in-hospital deaths within seven days for critically ill patients initially presenting to the FC was 9 of 29 and 21 of 38 before and after the outbreak, respectively ($p<0.05$) (see Table 3).

Length of stay in FC before and after the COVID-19 outbreak

The total length of stay in the FC was 22 (12,47) mins before the outbreak, compared with 442 (374,636) mins after the outbreak ($p<0.001$). While the total length of stay in the resuscitation rooms of the ED lengthened from 22 (7,59) hours to 48 (21,96) hours after the outbreak ($p<0.001$) (see Table 4).

Most commonly provided treatments in the FC were: antibiotics, antiarrhythmic drugs, antihypertensive drugs, and antiplatelet drugs. Common supportive treatments included: nasal catheter oxygen, non-invasive/invasive ventilation, fluid resuscitation, vasopressors, intracranial pressure reduction, and diuretic drugs. Initial treatment times are shown in Table 4.

Strengths and limitations

This study had several limitations. It was a restrospective study at a single center and carries the associated weaknesses of such study methodologies. Still, given the seriousness of the global fight against COVID-19, the lessons learned through the expansion of the FC and its relationship to the ED and ED patient flow are important concerns for global discussion. Future studies should examine the effects of having dedicated FC associated with ED, including the degree of integration with the ED vs. the rest of the hospital.

Discussion

COVID-19 is a deadly new respiratory infectious disease. This widely spreading disease became a notifiable infectious disease starting on January 20, 2020 per the National Health Commission of the People's Republic of China. Starting on January 20, the Beijing Municipal Government initiated a level-1 (highest) public health response to prevent the spread of the disease[12]. PUMCH upgraded the FC that same day to enhance the screening and treatment of potential COVID-19 patients. In this study, we reviewed the details of the FC in the 40 days before and after the COVID-19 outbreak. We found that after the outbreak, more patients received treatment in FC, critically ill patients received initial rescue management in the FC, and, most importantly, no

confirmed COVID-19 patients were transferred to the ED and no other patients, doctors or nurses were infected in the hospital. This FC upgrate strategy seemed to successfully prevent COVID-19 from spreading.

According to our data, upper respiratory infections were the major disease seen in the FC both before and after the COVID-19 outbreak. Most mild COVID-19 patients had upper respiratory infection syndromes [13] , but they also are strongly infectious, which causes dramatic difficulties in screening. Consequently, it was not possible to exclude COVID-19 merely based on clinical symptoms [14]. We found that patients' average age trended older after the outbreak [15]. A reasonable explanation for this was that patients with relatively severe diseases had to seek medical care in hospitals even though they faced a high risk of cross-infection with COVID-19. Older people generally have a higher risk of severe disease, but this difference did not exist in critically ill patients, likely because most critical patients were elderly people.

All patients in the FC were regarded as potential sources of infection, thus decreasing the number of patients who had to be transferred to the ED from the FC was an important strategy. Before the outbreak, the major work of the FC was identifying influenza, which might take about half an hour. Once negative results were reported, patients could be transferred to the ED with limited precautions. Once COVID-19 hit, frequent transfers between the FC and ED might cause crowded situations in the ED and increase exposure risks. Our data showed a lower transfer rate after the outbreak, likely due to increasing amounts of medical treatment (as opposed to just testing before the outbreak) in the FC. To those patients who were finally transferred to the ED within 24 hours, a longer FC retention time was observed due to the prolonged screening time for COVID-19. During their time in the FC, patients received treatments aimed at decreasing the number of patients in the ED. Even though some patients had to seek further medical advice in the ED, initial treatments given in the FC might also shorten their length of stay in the ED.

Intensive screening played an important role in COVID-19 identification. Before the outbreak, fever was the only screening indicator. Unfortunately, 11.5% of COVID-19 patients did not manifest fever, but as many as 82.4% of patients had respiratory symptoms, such as cough, expectoration and dyspnea[12]. These phenomena impelled us to expand screening criteria. Thus, all patients meeting one or more of the following conditions had to be screened in the FC: positive COVID-19 contact exposure, fever or respiratory symptoms. With this new criteria, the number of FC patients grew dramatically in the 40 days after January 20, 2020.

Multiple testing methods were trialed to decrease false negatives. As COVID-19 has diverse manifestations, it was unreliable to identify this disease based on only one method. In our screening process, multiple methods, including blood cell analysis, chest CT[16], SARS-COV-2 nucleic acid[17] and antibody tests[18] were used to screen for this disease. However, each method had its own false negative phenomena, therefore all patients suspected of any viral infection were recommended to receive another nucleic acid test once more in 24 hours, which helped guarantee that patients who didn't retest again and were transferred to the ED within 24 hours had an extremely low risk of COVID-19. Additionally, in order to avoid false negative results, patients with the following conditions were suggested to test for SARS-COV-2 nucleic acid once again

one week later, even though previous RNA tests were negative twice: (1) confirmed COVID-19 contact history; (2) clinical manifestations and lab tests suggesting a viral infection unexplained by another disease; (3) chest CT strongly indicating a viral pneumonia. With these strict screening criteria, no COVID-19 cases were diagnosed in ED patients previously seen in the FC.

An effective triage strategy also lowered cross-infection risks. As the number of FC patients grew rapidly, cross-infection prevention was a central concern. According to their COVID-19 contact history and clinical severity, patients were allocated to one of three specialized regions of the FC. First, patients with positive contact histories were suggested to keep a person-to-person distance of at least two meters before further history details were investigated, and only when all tests were reported negative could they leave the FC. Second, critical patents identified at the triage counter were immediately admitted to rescue rooms where experienced physicians would provide further assessment and initial resuscitation. Thus, before the results of the screening tests came out,patients were all treated as potentially infected. Once negative results were reported, they could be transferred to the ED resuscitation rooms; otherwise they would continue being treated in the FC or transferred to dedicated receiving hospitals for COVID-19. Third, FC patients could now begin to receive initial treatment(s) as soon as possible without waiting for transfer to the ED.

This study did show that the seven day mortality rate for critically ill patients was higher after the outbreak than before, even though there were no significant differences of the initial treatment time.Although this may be due to the presence of COVID-19 in the patient population after the outbreak, this may also indicate that the longer length of stay in the FC and resuscitation room in the ED after the outbreak may themselves be factors leading to poor outcomes.

Since the outbreak, nineteen FC patients have been confirmed to be positive for COVID-19. It should be noted that all of these positive cases were identified in the FC and received initial treatment there. More importantly, all patients and medical staff in contact with these patients were strictly followed-up for 14 days and no cross-infections were found.

This retrospective study showed the effect of the changes enacted in the FC at the time of the COVID-19 outbreak. The modifications taken in the FC to change the triage, testing, and treatment pathways had a dramatic effect on the FC,as well as offload ED resources.. Although further studies are needed to determine the exact effects of the FC, the lack of cross-contamination events in the ED seem to suggest a possible avenue to EDs around the world to both safeguard their existing ED patients while appropriately caring for potential COVID-19 patients.

Declarations

Ethics approval and consent to participate

This retrospective study was approved by The Ethics Committee of the Peking Union Medical College Hospital，the committee’s reference number:S-K1091.

All of the data used in this study was anonymised before its use.

The data information is available at the hospital information system of PUMCH.
Written informed consent was obtained from all participants

Conflicts of interest: We declare no conflicts of interest.

Author contributions: JSW and JHL were responsible for the conception and design of the study.JSW,HS, PXS, SYX,YL,JX,and CTW collected the data, LZ and FL were in charge of statistical analysis.LZ, JSW and JHZ took part in drafting the manuscript. JHW,YLand HDZ revised and approved the final version of the manuscript. All authors read and approved the final submitted version.

Acknowledgements
We appreciate each doctor working in the fever clinic that help control the COVID-19. Special thanks to Jinghong Zhang and Joseph Harold Walline for their advice on reviewing manuscript.

References

[1] Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, et al. A Novel Coronavirus from Patients with Pneumonia in China, 2019. N Engl J Med 2020;382:727-33. doi:10.1056/NEJMoa2001017.

[2] World Health Organization. Coronavirus disease (COVID-2019) situation report #68. March 28, 2020 Available online: https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200328-sitrep-68-covid-19.pdf?sfvrsn=384bc74c_2. Accessed March 29, 2020.

[3] Lai CC, Shih TP, Ko WC, Tang HJ, Hsueh PR. Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and coronavirus disease-2019 (COVID-19): The epidemic and the challenges. Int J Antimicrob Agents 2020;55:105924. doi:10.1016/j.ijantimicag.2020.105924.

[4] Guan WJ, Ni ZY, Hu Y, Liang WH, Ou CQ, He JX ,et al. Clinical Characteristics of Coronavirus Disease 2019 in China. N Engl J Med.2020. doi: 10.1056/NEJMoa2002032.

[5] COVID-19: protecting health-care workers. The Lancet. 2020. DOI:https://doi.org/10.1016/S0140-6736(20)30644-9.

[6] Webster P.Canada and COVID-19: learning from SARS. The Lancet. 2020;395(10228):936-937.

[7] Hu Z, Song C, Xu C, Jin G, Chen Y, Xu X,et al.Clinical characteristics of 24 asymptomatic infections with COVID-19 screened among close contacts in Nanjing, China. 2020. doi: 10.1007/s11427-020-1661-4.

[8] Amrane S, Tissot-Dupont H, Doudier B, Eldin C, Hocquart M, Mailhe M,et al.Rapid viral diagnosis and ambulatory management of suspected COVID-19 cases presenting at the infectious diseases referral hospital in Marseille, France, - January 31st to March 1st, 2020: A respiratory virus snapshot. Travel Med Infect Dis. 2020.doi: 10.1016/j.tmaid.2020.101632.

[9] Zhang MQ, Wang XH, Chen YL, Zhao KL, Cai YQ, An CL ,et al.Clinical features of 2019 novel coronavirus pneumonia in the early stage from a fever clinic in Beijing. Chinese journal of tuberculosis and respiratory diseases. 2020 ,43(3):215-218.

[10] National Health Commission of the People's Republic of China. Technical guidelines for the protection to health care provider during the 2019 Coronavirus Disease (COVID-19) epidemic. Jan 23,

2020. Available online: http://www.nhc.gov.cn/yzygj/s7659/202001/b91fdab7c304431eb082d67847d27e14.shtml. Accessed March 12, 2020.

[11] National Health Commission of the People's Republic of China. Diagnosis and treatment of novel coronavirus pneumonia . (7th trial version). March 4, 2020. Available online: http://www.nhc.gov.cn/yzygj/s7653p/202003/46c9294a7dfe4cef80dc7f5912eb1989/files/ce3e6945832a438eaae415350a8ce964.pdf.Accessed March 15, 2020

[12] Deng SQ, Peng HJ. Characteristics of and Public Health Responses to the Coronavirus Disease 2019 Outbreak in China. J Clin Med 2020;9. doi:10.3390/jcm9020575.

[13] Chang, Lin M, Wei L, Xie L, Zhu G, Dela Cruz CS, et al. Epidemiologic and Clinical Characteristics of Novel Coronavirus Infections Involving 13 Patients Outside Wuhan, China. JAMA 2020. doi:10.1001/jama.2020.1623.

[14] Li LQ, Huang T, Wang YQ, Wang ZP, Liang Y, Huang TB, et al. 2019 novel coronavirus patients' clinical characteristics, discharge rate and fatality rate of meta-analysis. J Med Virol 2020. doi:10.1002/jmv.25757.

[15] Armitage R, Nellums LB. COVID-19 and the consequences of isolating the elderly. The Lancet. Public health.2020.doi: 10.1016/S2468-2667(20)30061-X.

[16] Xiong Z, Fu L, Zhou H, Liu JK, Wang AM, Huang Y, et al. Construction and evaluation of a novel diagnosis process for 2019-Corona Virus Disease. Zhonghua Yi Xue Za Zhi 2020;100:E019. doi:10.3760/cma.j.cn112137-20200228-00499.

[17] Corman VM, Landt O, Kaiser M, Molenkamp R, Meijer A, Chu D, et al. Detection of 2019 novel coronavirus (2019-nCoV) by real-time RT-PCR. Euro Surveill 2020;25. doi:10.2807/1560-7917.ES.2020.25.3.2000045.

[18] Li Z, Yi Y, Luo X, Xiong N, Liu Y, Li S, et al. Development and Clinical Application of A Rapid IgM-IgG Combined Antibody Test for SARS-CoV-2 Infection Diagnosis. J Med Virol 2020. doi:10.1002/jmv.25727.

Tables

Table 1: Patient Characteristics and Disease Etiologies

Characteristics	Before the outbreak	After the outbreak	*P* value
Total patients	2912	3453	
Age (years)	41 (31,61)	47 (33,67)	0.001
Sex, n (%)			0.632
Male	1204 (41.35)	1532 (44.36)	
Female	1708 (58.65)	1921 (55.63)	
Influenza A virus, n (%)	276 (9.47)	67 (1.94)	<0.001
Influenza B virus, n (%)	52 (1.78)	26 (0.75)	<0.001
COVID-19, n (%)	0 (0)	19 (0.55)	<0.001
Critical patients, n (%)	29 (1.00)	38 (1.10)	0.713
Febrile patients, n (%)	2846 (97.73)	2306(66.78)	<0.001
Infectious diseases, n (%)	2304 (79.12)	2543 (73.65)	<0.001
Upper respiratory infection	1699 (58.34)	1931(55.92)	
Pneumonia	154 (5.28)	102(2.95)	
Cardiovascular infection	6 (0.20)	6 (0.17)	
Abdomino-pelvic infection	207 (7.10)	310 (8.98)	
Skin or soft tissue infection	40 (1.37)	55 (1.59)	
Urinary tract infection	77 (2.64)	54(1.56)	
Conjunctivitis	4 (0.14)	4 (0.11)	
Otitis media	2 (0.07)	2 (0.05)	
Central nervous system infection	2 (0.07)	8 (0.23)	
Tuberculosis	4 (0.14)	4(0.11)	
Brucellosis	4 (0.14)	0(0)	
Unknown origin infections	105 (3.60)	67 (1.94)	
Non-infectious diseases, n (%)	57 (1.95)	42 (1.22)	0.876
Hematologic malignancy	7 (0.24)	4(0.11)	
Hyperthyroidism	2 (0.07)	2(0.05)	
Autoimmune disease	48 (1.64)	36(1.04)	
Fever of unknown origin, n (%)	15 (0.51)	8(0.23)	0.091
Other, n (%)	536 (18.42)	860(24.90)	<0.001

Table 2: FC to ED transfer data before and after the COVID-19 outbreak

Characteristics	Before the outbreak	After the outbreak	*P* value
FC Patients transferred to ED, n (%)	1142 (39.21)	544 (15.75)	<0.001
Age (years)	39 (30,59)	46 (32,63)	0.001
Sex, n (%)			0.541
Male	491 (42.99)	243 (44.67)	
Female	651 (57.01)	301 (55.33)	
Patients transferred from FC to ED within 24 hours, n (%)	1083 (94.84)	482 (88.60)	<0.001
Time interval between FC and ED (min)	55 (42,74)	203 (81,468)	<0.001

Table 3 Characteristics and Disease Etiologies of Critically Ill Patients

Characteristics	Before the outbreak	After the outbreak	*P* value
Critical patients, n (%)	29(1.00)	38(1.10)	0.713
Age (years)	59.45±19.86	63 (47,78)	0.735
Sex, n (%)			0.630
Male	15 (51.72)	22 (57.89)	
Female	14 (48.28)	16 (42.11)	
APACHE II score	16.1±6.67	18.74±6.72	0.116
Diagnosis, n (%)			
Fever	29 (100)	38 (100)	
Septic shock	9(31.03)	12(31.58)	
Pneumonia with respiratory failure	9(31.03)	10(26.31)	
Acute myocardial infarction	2(6.70)	2(5.26)	
Gastrointestinal bleeding	2(6.90)	1(2.63)	
Acute cerebrovascular disease	1(3.45)	4(10.52)	
Intracranial metastasis of lymphoma	0(0)	1(2.63)	
Central nervous system infection	2(6.90)	1(2.63)	
Acute myocarditis	1(3.45)	1(2.63)	
Tachyarrhythmia	2(6.90)	0(0)	
Ruptured iliac aneurysm	1(3.45)	0(0)	
Acute aortic dissection	0(0)	1 (2.63)	
Diffuse alveolar hemorrhage with SLE	0(0)	1(2.63)	
Acute left heart failure	0(0)	2(5.26)	
Acute pulmonary embolism	0(0)	1(2.63)	
Hyperosmolar hyperglycemic state	0(0)	1(2.63)	
Prognosis, n (%)			0.021
Improvement	16 (55.17)	17 (44.74)	
Non-improvement	4 (13.79)	0(0)	
Death	9 (31.03)	21 (55.26)	

SLE=Systemic Lupus Erythematosus

Table 4: Length of Stay in the FC Before and After the COVID-19 outbreak

Characteristics	Before the outbreak	After the outbreak	*P* value
FC total length of stay (minutes)	22 (12,47)	442 (374,636)	<0.001
ED resuscitation room total length of stay (hours)	22 (7,59)	48 (21,96)	<0.001
Treatment times (minutes)	165(95,241)	123 (78,164)	0.072
Supportive treatment times (minutes)	153.2±100.3	72 (34,160)	0.065

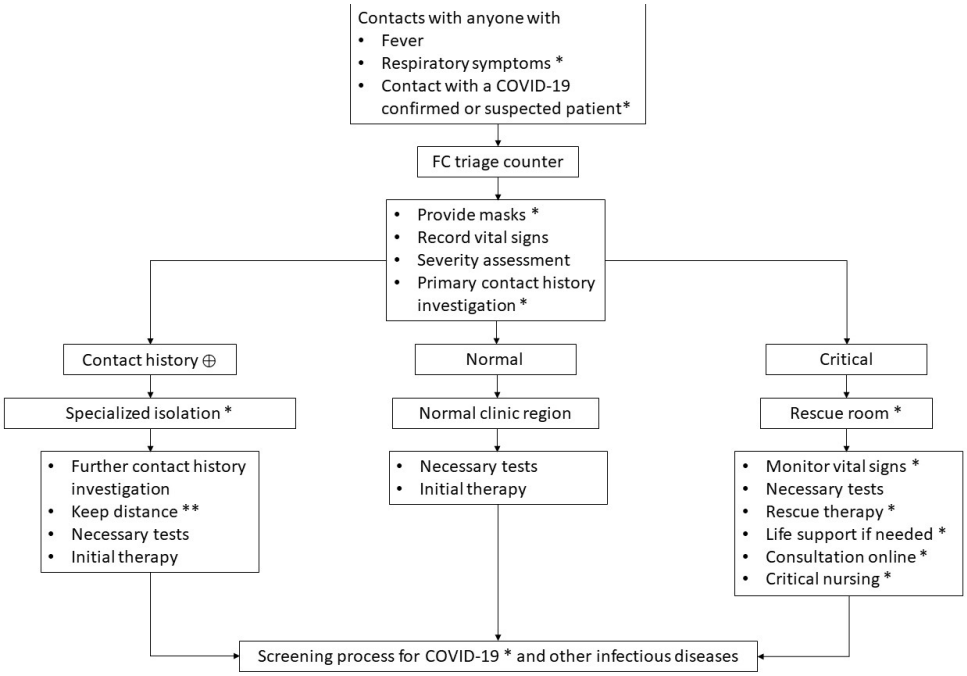
Figure legend

Figure 1 Triage process and regional isolation for different patients in the FC. * Upgraded FC parts. ** Educate patients to maintain a person-to-person distance greater than two meters. Abbreviations: FC: fever clinic, ⊕: positive, COVID-19: coronavirus disease 2019.

Figure 2 Screening process for COVID-19 and other respiratory infectious diseases. * Upgraded FC parts. ** After the COVID-19 outbreak, Chest CT was suggested as a routine examination for patients in FC excluding special populations such as pregnant women and children. *** Patients are recommended to test for SARS-COV-2 RNA again one week later even if previous RNA tests were negative twice if they have: (1) confirmed COVID-19 contact history; (2) clinical manifestations and lab tests implying viral infection which can not be explained by other diseases; (3) chest CT strongly suggestive of viral pneumonia. Abbreviations: , COVID-19: coronavirus disease 2019, ⊕: positive, ⊖: negative, CT: computed tomography, SARS-COV-2: severe acute respiratory syndrome coronavirus 2, NA: nucleic acid, ED: emergency department, IDR: infectious disease report, FC: fever clinic.

Abbreviations:

COVID-19: Corona Virus Disease 2019
SARS-COV-2: Severe Acute Respiratory Syndrome Coronavirus 2
PUMCH: Peking Union Medical College Hospital
ED: Emergency Department
FC: Fever Clinic
CT:Computed Tomography
APACHE II: Acute Physiology and Chronic Health Examination (APACHE) II score
IDR: Infectious Disease Report
NA: Nucleic Acid
SLE:Systemic Lupus Erythematosus



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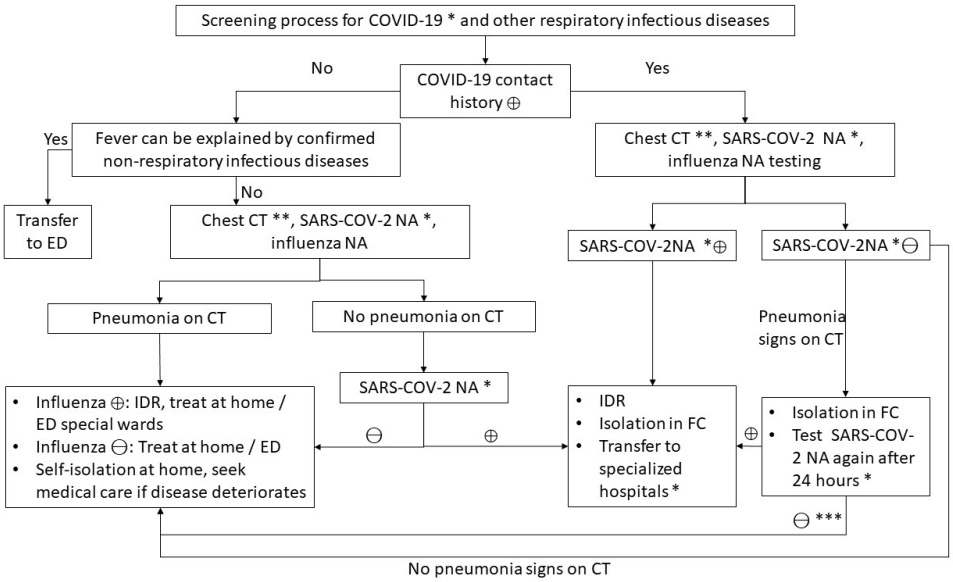

Figure 2 Screening process for COVID-19 and other respiratory infectious diseases. * Upgraded FC parts. ** After the COVID-19 outbreak, Chest CT was suggested as a routine examination for patients in FC excluding special populations such as pregnant women and children. *** Patients are recommended to test for SARS-COV-2 RNA again one week later even if previous RNA tests were negative twice if they have: (1) confirmed COVID-19 contact history; (2) clinical manifestations and lab tests implying viral infection which can not be explained by other diseases; (3) chest CT strongly suggestive of viral pneumonia. Abbreviations: , COVID-19: coronavirus disease 2019, ⊕: positive, ⊖: negative, CT: computed tomography, SARS-COV-2: severe acute respiratory syndrome coronavirus 2, NA: nucleic acid, ED: emergency department, IDR: infectious disease report, FC: fever clinic.

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BMJ Open

Separate Fever Clinics Prevent the Spread of COVID-19 and Offload Emergency Resources: Analysis from a large tertiary hospital in China

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2020-039177.R1
Article Type:	Original research
Date Submitted by the Author:	12-Jun-2020
Complete List of Authors:	WANG, JIANGSHAN; Peking Union Medical College Hospital Zong, Liang; Peking Union Medical College Hospital Zhang, Jinghong; School of Medicine, Monash University, Melbourne, Victoria, Australia Sun, Han; Peking Union Medical College Hospital Joseph, Harold; Accident and Emergency Medicine Academic Unit, Prince of Wales Hospital, The Chinese University of Hong Kong, Hong Kong, China Sun, Pengxia; Peking Union Medical College Hospital Xu, Shengyong; Peking Union Medical College Hospital Li, Yan; Peking Union Medical College Hospital Wang, Chunting; Peking Union Medical College Hospital Liu, Jihai; Peking Union Medical College Hospital Li, Fan; Peking Union Medical College Hospital Xu, Jun; Peking Union Medical College Hospital Li, Yi; Peking Union Medical College Hospital Yu, Xuezhong; Peking Union Medical College Hospital Zhu, Huadong; Peking Union Medical College Hospital, emergency
Primary Subject Heading:	Emergency medicine
Secondary Subject Heading:	Infectious diseases, Medical management
Keywords:	HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Health policy < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Public health < INFECTIOUS DISEASES, ACCIDENT & EMERGENCY MEDICINE

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Separate Fever Clinics Prevent the Spread of COVID-19 and Offload Emergency Resources: Analysis from a large tertiary hospital in China

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Word count for the text ：3305

Funding：This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Abstract

Objectives: COVID-19 began spreading widely in China in January 2020. Outpatient "Fever Clinics" (FCs), instituted during the SARS epidemic in 2003 were upgraded to provide COVID-19 screening and prevention attached to large tertiary hospitals. We sought to analyze the effect of upgraded FCs to detecting COVID-19 at our institution.

Design: A population-based cross-sectional study.

Participants: A total of 6,365 patients were screened in the FC.

Methods: The FC of Peking Union Medical College Hospital (PUMCH) was upgraded on January 20, 2020. We performed a retrospective study of patients presenting to the FC between December 12, 2019 to February 29, 2020. January 20, 2020 was the date when COVID-19 was declared an outbreak in Beijing. Two groups of data were collected and subsequently compared with each other: The first group of data was collected within 40 days before January 20, 2020; The second group of data was collected within 40 days after January 20, 2020. All necessary data, including baseline patient information, diagnoses, follow-up conditions for critical patients, transfer information between the FC and Emergency Department (ED) were documented and analyzed.

Results: 6,365 patients were screened in the FC, among whom 2,912 patients were screened before January 21, 2020, while 3,453 were screened afterwards. Screening results showed that upper respiratory infection was the major disease associated with fever. Compared to before the outbreak, the number of patients who were transferred from the FC to ED decreased significantly [39.21% vs 15.75%, p<0.001] and tended to spend more time in the FC [55 vs 203minutes, p<0.001]. For critically ill patients waiting for the screening result, the total length of stay in the FC was 22minutes before the outbreak, compared to 442minutes after the outbreak (p< 0.001). The number of in-hospital deaths of critically ill patients seen in the FC was 9 of 29 patients before the outbreak and 21 of 38 after (p<0.05). 19 COVID-19 cases were confirmed in the FC during the study period, but no other patients or medical care providers were cross-infected.

Conclusion: The workload of the FC increased after the COVID-19 outbreak. New measures and protocols have effectively prevented the spread of COVID-19 in the hospital, as well as offload ED resources.

Key words: COVID-19 outbreak, fever clinic, emergency department, disease screening, disease prevention

Introduction

Background

Coronavirus disease 2019 (COVID-19) caused by the severe acute respiratory syndrome coronavirus 2 (SARS-COV-2) broke out in Wuhan, Hubei Province at the end of 2019[1], and cases are now rapidly spreading worldwide [2] . Currently, controlling the spread of SARS-CoV-2 is of primary concern [3]. The main manifestations of this disease include acute fever, cough and dyspnea [4], thus emergency departments (EDs) have become the primary facilities providing initial diagnoses and medical care for potential COVID-19 patients. Unfortunately, as the virus spreads widely, crowded patients in EDs face a high risk of cross-infection [5,6]. In mainland China, outpatient "fever clinics" (FCs), affiliated to the ED, are designed to help separate potentially infectious from non-infectious patients [7]. FCs were started at the suggestion of National Health Commission of the People's Republic of China as early as 2003 during the SARS outbreak in China Even after the SARS event, FCs were still preserved as a location near EDs for early identification and isolation of patients with potential infectious diseases [8]. Therefore, fewer suspected patients were actually managed in the emergency department [9]. However, between SARS in 2003 and the current COVID-19 outbreak, the FC system has faced less challenges since SARS and the importance of this potential key element of hospital infection-prevention infrastructure has been largely neglected.

FC upgrade after the COVID-19 outbreak

Before the COVID-19 outbreak, four doctors were allocated to the FC where influenza A and B were screened for every patient suffering from both fever and respiratory symptoms. The FC was also tasked with excluding eruptive infectious diseases (e.g. measles, rubella, and varicella). Patients with infectious diseases received initial therapy in the FC, and then were transferred to inpatient isolation wards if needed; other patients were transferred to the ED. After the COVID-19 outbreak, as many as twelve doctors wearing "grade-3" personal protective equipment (PPE)worked in the FC[10], including a disposable medical protective suit, an isolation gown, N95 filtering facepiece respirator, goggles, disposable full-face shield, two layers of clean gloves and boot covers. Two consulting rooms were added to supplement the original single room. The number of medical care providers providing in-person coverage every 24 hours increased from two to nine every 24 hours, while nursing staff increased from nine to fifteen every 24 hours. Rescue equipment such as endotracheal intubation tools, central venous catheters, noninvasive and invasive ventilator machines, high-flow oxygen therapy devices and bedside ultrasound were added or expanded.

All patients with either fever or respiratory symptoms, no matter with or without a history of COVID-19 exposure, were mandated to go through FC triage (Figure 1). Each patient was required to wear a mask on arrival to the FC and was allocated to different regions according to

their triage history and clinical severity (Figure 1). The FC took responsibility for screening SARS-COV-2, in addition to influenza and eruptive diseases noted above. All acquired nucleic acid samples were tested by two independent laboratories that had been authorized by the Beijing Municipal Health Commission. Only "double negative" results were accepted as a negative result for the patient. In addition to identification, there were specialized doctors in charge of suspected patients, critical patients and common patients, respectively. Negative pressure isolation wards with complete sets of resuscitation equipment were readied for any critical patients. Once the screening tests were reported, confirmed patients would be transferred to specialized hospitals whereas others who needed further treatment were subsequently transferred into the ED (Figure 2).

Methods

Data collection

We collected data from all patients who presented to the FC of PUMCH in the last 40 days before the FC upgradation (from December 12, 2019 to January 20, 2020), and for another 40 days after the FC upgradation (from January 21 to February 29, 2020). The FC was upgraded on January 20, 2020 which was also the official date when COVID-19 was declared an "outbreak" in Beijing. We included all critically ill patients during this period who initially presented to the FC and subsequently transferred to the ED. The data were collected from patients' medical records and their registration information at the time of presentation. Patients' clinical condition, primary diagnoses, time of registration (FC and, potentially, ED), as well as the duration of consultation at each visit were documented.

Critically ill patients were identified according to the following criteria: (1) patients transferred to resuscitation rooms in the ED from the FC after initial screening and initial treatment; (2) APACHE II score ≥8; (3) patients who were ruled out the possibility of COVID-19 pneumonia[11]. Critically ill patients' prognoses and treatment results were documented in their medical records, as well as any changes in patients' condition within seven days following initial presentation to the FC (e.g. improvement, non-improvement or death).

Patient and Public Involvement:

This was a retrospective study, we collected medical information of all involved patients from the electronic information system. Patients were not involved in the recruitment for any trials or any particular study designs.

Statistics

Statistical Package for Social Sciences 24.0 software (IBM Corp., Aramonk, NY, USA) was used for statistical analysis. The Kolmogorov-Smirnov test was used to determine the normal distribution of variables. Variables with normal distribution are shown as a mean (±SD). T-tests were used for variables that followed normal distribution. Data that did not follow normal distribution was shown as a median (25%-75%) and analyzed by the Wilcoxon rank sum test. Chi-square tests and Fisher's exact tests were used for enumeration data. P-values less than 0.05 were taken to indicate statistical significance.

Results

Patient Characteristics and Disease Etiologies

In total, 6,365 patients were screened in the FC, among whom 2,912 patients were screened before the outbreak, and 3,453 patients were screened after the outbreak was declared and the FC was upgraded on January 20, 2020. There was no statistical difference in sex ratio between the two groups, but a significant difference in age was seen (p=0.001). The most common disease found in the FC was upper respiratory infection, followed by abdomino-pelvic infection and pneumonia (Table 1). From January 24 to February 11, 19 patients were diagnosed as COVID-19 at the FC; all of these patients had mild to moderate manifestation, and there was no severe or critical COVID cases. It is worth mentioning that all patients and medical staff who were in contact with those 19 patients with COVID-19 were strictly followed-up for 14 days and no cross-infections were found.

Transfer from FC to ED before and after the COVID-19 outbreak

The number of registered patients who presented first to the FC and were subsequently transferred to the ED before and after the outbreak was 1,142 and 544, respectively. There was no statistical difference in sex ratio or age of patients between these two groups (p>0.05). 1,083 (94.84%) of cases before the outbreak took less than 24 hours to transfer from the FC to ED. After the outbreak, 482 cases met this benchmark (p<0.001). Meanwhile, the treatment time in the FC grew significantly longer compared to before the outbreak (p<0.001) (Table 2).

Critically ill patients

69 critically ill patients were initially identified in our analysis, and 2 patients were subsequently excluded due to an APACHE II score < 8 points. Among 67 patients, 29 visited the FC before the outbreak while 38 presented after the outbreak. The ratio of male to female patients was 1.23:1 and the median age was 63 (47,78). There was no significant difference in sex ratio or age of patients between the two groups (p>0.05). There was also no significant difference in the severity of disease between the two groups when examining their respective APACHE II scores (16.1±6.67 vs 18.74±6.72). Patients with septic shock and pneumonia combined with respiratory failure accounted for most diagnoses. The number of in-hospital deaths within seven days for critically ill patients initially presenting to the FC was 9 of 29 and 21 of 38 before and after the outbreak, respectively (p<0.05) (Table 3).

Length of FC stay before and after the COVID-19 outbreak

The total length of stay in the FC was 22 (12,47) minutes before the outbreak, compared with 442 (374,636) minutes after the outbreak (p<0.001). While the total length of stay in the resuscitation rooms of the ED lengthened from 22 (7,59) hours to 48 (21,96) hours after the outbreak (p<0.001) (Table 4).

The most commonly provided medications in the FC were: antibiotics, antiarrhythmic, antihypertensive and antiplatelet drugs. Common supportive treatments included: nasal catheter oxygen, non-invasive/invasive ventilation, fluid resuscitation, vasopressors, intracranial pressure reduction and diuretic drugs. Initial treatment time has been shown in Table 4.

Strengths and limitations

This study had several limitations. It was a retrospective study at a single center and carried the associated weaknesses of such study methodologies. Still, given the seriousness of the global battle against COVID-19, the lessons learned through the expansion of the FC and its relationship to the ED, and the transfer of ED patients are important concerns for global discussion. Future studies should examine the effects of having dedicated FC associated with ED, including the degree of integration with the ED compared with the integration of FC with other disciplines of the hospital.

Discussion

COVID-19 is a novel infectious disease of the respiratory system. This widely spreading disease has become a notifiable infectious disease since January 20, 2020 per the National Health Commission of the People's Republic of China. From January 20, the Beijing Municipal Government initiated a level-1 (highest) public health response to prevent the spread of the disease[12]. PUMCH upgraded its FC on the same day in order to enhance the screening and treatment of potential COVID-19 patients. In this study, we reviewed and compared the details of the FC in the 40 days pre and post the COVID-19 outbreak. We found that after the outbreak, the FC has played a more important role in delivering treatment compared to before, and that critically ill patients received their initial management in the FC without being transferred to the ED. Patients would subsequently be transferred to the ED for further treatment if they had been tested negative by two different laboratories. As a result, no COVID-19 cases were identified in the ED during the post-outbreak period, and more importantly, no other patients, doctors or nurses were infected with COVID-19 in the hospital. Therefore, the FC upgradation seemed to have successfully prevented the spread of COVID-19.

According to our data, upper respiratory infections were the major disease seen in the FC both before and after the COVID-19 outbreak. Most mild COVID-19 patients had upper respiratory infection syndromes [13] which were also strongly infectious that had caused substantial difficulty on the screening process. It was not possible to exclude COVID-19 merely based on clinical symptoms [14]. We found that patients' average age tended to be older after the outbreak [15]. A reasonable explanation for this was that patients with relatively severe diseases had to seek medical care in hospitals even though they faced a high risk of cross-infection with COVID-19. Older people generally have a higher risk of developing severe diseases, but the difference in age between the two groups did not exist in critically ill patients in our study, which could be attributed to the fact that most critically ill patients were older.

All patients staying in the FC were regarded as potential sources of infection, thus decreasing the

number of patients who had to be transferred to the ED from the FC was an important strategy. Before the outbreak, the major work of the FC was identifying influenza, which might take about 30 minutes. Once negative results were reported, patients would be allowed to be transferred to the ED with limited precautions. After COVID-19 outbreak was declared, our data showed that there was a decrease in the transfer of patients from the FC to ED in order to reduce the chance of overcrowding the ED, as well as minimizing the likelihood of the spread of COVID-19. For patients who were eventually transferred to the ED, a longer FC retention time was recorded due to the prolonged screening time for COVID-19. During the stay in the FC for certain patients, they actually received curative, rather than supportive, treatments so that they did not have to be transferred to ED for further management. Even though some patients had to seek further management in the ED, their initial treatments were given in the FC might have contributed a shorter length of stay in the ED. Therefore, patients and medical staff working at ED could be largely protected from contracting COVID-19.

Intensive screening also played an important role in COVID-19 identification. Before the outbreak, fever was the only screening indicator. Unfortunately, 11.5% of COVID-19 patients did not manifest fever, but as many as 82.4% of patients had respiratory symptoms, such as cough, expectoration and dyspnea[12]. These phenomena impelled us to expand screening criteria. Therefore, all patients meeting one or more of the following conditions had to be screened in the FC: (1) positive COVID-19 contact exposure.(2) fever. (3) respiratory symptoms. With the new criteria in place, the number of FC patients grew dramatically in the following 40 days after January 20, 2020.

Multiple testing methods were trialed to decrease false negatives. As COVID-19 has shown diverse manifestations, it is unreliable to identify this disease based on only one method. In our screening process, multiple methods, including blood cell analysis, chest CT[16], SARS-COV-2 nucleic acid[17] and antibody tests[18] were used to screen for this disease. However, each method had its own false negative limitation, therefore all patients suspected of any viral infection were recommended to receive a further nucleic acid test after 24 hours of the first test. This method has assured that patients who were subsequently transferred to the ED from FC had a minimum risk of spreading COVID-19 in the hospital. In addition, in order to avoid false negative results, patients with the following conditions were suggested to be tested for SARS-COV-2 nucleic acid once again after one week: (1) confirmed COVID-19 contact history. (2) clinical manifestations and lab testing suggests a viral infection that is unexplained by another disease.(3) chest CT indicates viral pneumonia, despite their previous negative nucleic acid testing. With these strict screening criteria imposed, no COVID-19 cases were diagnosed among patients in the ED who were previously present in the FC.

An effective triage strategy also lowered cross-infection risks. As the number of FC patients grew rapidly, cross-infection prevention had become a major concern. According to their COVID-19 contact history and clinical severity, patients were allocated to one of three specialized regions of the FC. Firstly, patients with positive contact history were suggested to keep a person-to-person distance of at least two meters before further history details were investigated, and only when all tests were reported negative could they leave the FC. Secondly,

critical patents identified at the triage counter were immediately admitted to rescue rooms where experienced physicians would provide further assessment and initial resuscitation. Thus, before the results of the screening tests came back, patients were all treated as potentially infected. Once negative results were reported, they were allowed to be transferred to the ED resuscitation rooms; otherwise they would continue being treated in the FC or transferred to the designated hospitals for COVID-19. Thirdly, FC patients could start to receive their initial treatment as soon as possible without waiting to be transferred to the ED.

Furthermore, the infection control measures in the FC were of vital importance. After the COVID-19 outbreak, PPE worn by healthcare workers in the FC was upgraded to a higher infection-control standard. All consulting rooms and observation rooms are negative-pressure rooms. Each consulting room was sterilized by ultraviolet for one hour every day, and by alcohol (75%) spray for all the surfaces (e.g. desks, computers, keyboards and printers) once every four hours. Negative-pressure airborne infection isolation observation rooms were also sterilized by ultraviolet for one hour every day even when no patients were admitted. When a patient left the observation room, ultraviolet sterilization for the room, alcohol spray for surfaces were performed immediately.

This study also showed that the seven-day mortality rate for critically ill patients was higher after the outbreak (21/38) compared to before the outbreak (9/29), Firstly, the sample size was small in both groups, thus sampling error was hard to avoid. Secondly, 2 patients from the 9/29 group and 7 patients from the 21/38 group actually declared 'DO NOT RESUSCITATE' (DNR). If these DNR patients were excluded from their respectively study groups, the mortality rate would become 7/29 in the first group (before the outbreak) and 14/38 in the second group (after the outbreak). Thirdly, the new policy at PUMCH during COVID-19 stated that critically ill patients from the ED could not be promptly admitted into the Intensive Care Unit (ICU) and other specialist ward, in order to prevent the spread of COVID-19 in the hospital. The longer total length of stay in the FC and ED after the outbreak of COVID-19, which may affect the critically ill patient's short-term prognoses.

This retrospective study demonstrated the effect of the changes enacted in the FC at the time of the COVID-19 outbreak. The modifications occurred in the FC aiming to change the triage, testing, and treatment process had had a positive and significant effect on the FC efficiency, as well as offload ED resources. Although further studies are needed to determine the exact effects of the FC, the lack of cross-contamination events in the ED because of the presence of FC seems to strongly suggest a possible avenue to EDs around the world to both safeguard their existing ED patients while appropriately caring for potential COVID-19 patients.

Declarations

Ethics approval and consent to participate

This retrospective study was approved by The Ethics Committee of the Peking Union Medical College Hospital , the committee's reference number:S-K1091.
All of the data used in this study was anonymised before its use.
The data information is available at the hospital information system of PUMCH.
Written informed consent was obtained from all participants

Conflicts of interest: We declare no conflicts of interest.

Author contributions: JSW and JHL were responsible for the conception and design of the study.JSW,HS,PXS,SYX,YL(Yan Li),JX,and CTW contributed to literature search and data collection, LZ and FL were in charge of statistical analysis and data interpretation .LZ, JSW and JHZ took part in drafting the manuscript. JHW, XZY,YL(Yi Li)and HDZ revised and approved the final version of the manuscript. All authors read and approved the final submitted version. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

Acknowledgements

We appreciate each healthcare provider working in the fever clinic and emergency department that help control the COVID-19. Special thanks to Jinghong Zhang and Joseph Harold Walline for their advice on reviewing manuscript.

References

[1] Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, et al. A Novel Coronavirus from Patients with Pneumonia in China, 2019. N Engl J Med 2020;382:727-33. doi:10.1056/NEJMoa2001017.

[2] World Health Organization. Coronavirus disease (COVID-2019) situation report #68. March 28, 2020 Available online: https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200328-sitrep-68-covid-19.pdf?sfvrsn=384bc74c_2. Accessed March 29, 2020.

[3] Lai CC, Shih TP, Ko WC, Tang HJ, Hsueh PR. Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and coronavirus disease-2019 (COVID-19): The epidemic and the challenges. Int J Antimicrob Agents 2020;55:105924. doi:10.1016/j.ijantimicag.2020.105924.

[4] Guan WJ, Ni ZY, Hu Y, Liang WH, Ou CQ, He JX ,et al. Clinical Characteristics of Coronavirus Disease 2019 in China. N Engl J Med.2020. doi: 10.1056/NEJMoa2002032.

[5] COVID-19: protecting health-care workers. The Lancet. 2020. DOI:https://doi.org/10.1016/S0140-6736(20)30644-9.

[6] Webster P.Canada and COVID-19: learning from SARS. The Lancet. 2020;395(10228):936-937.

[7] Hu Z, Song C, Xu C, Jin G, Chen Y, Xu X,et al.Clinical characteristics of 24 asymptomatic infections with COVID-19 screened among close contacts in Nanjing, China. 2020. doi: 10.1007/s11427-020-1661-4.

[8] Amrane S, Tissot-Dupont H, Doudier B, Eldin C, Hocquart M, Mailhe M,et al.Rapid viral diagnosis and ambulatory management of suspected COVID-19 cases presenting at the infectious diseases referral hospital in Marseille, France, - January 31st to March 1st, 2020: A respiratory virus snapshot. Travel Med Infect Dis. 2020.doi: 10.1016/j.tmaid.2020.101632.

[9] Zhang MQ, Wang XH, Chen YL, Zhao KL, Cai YQ, An CL ,et al.Clinical features of 2019 novel coronavirus pneumonia in the early stage from a fever clinic in Beijing. Chinese journal of tuberculosis and respiratory diseases. 2020 ,43(3):215-218.

[10] National Health Commission of the People's Republic of China. Technical guidelines for the protection to health care provider during the 2019 Coronavirus Disease (COVID-19) epidemic. Jan 23, 2020. Available online: http://www.nhc.gov.cn/yzygj/s7659/202001/b91fdab7c304431eb082d67847d27e14.shtml. Accessed March 12, 2020.

[11] National Health Commission of the People's Republic of China. Diagnosis and treatment of novel coronavirus pneumonia . (7th trial version). March 4, 2020. Available online: http://www.nhc.gov.cn/yzygj/s7653p/202003/46c9294a7dfe4cef80dc7f5912eb1989/files/ce3e6945832a438eaae415350a8ce964.pdf.Accessed March 15, 2020

[12] Deng SQ, Peng HJ. Characteristics of and Public Health Responses to the Coronavirus Disease 2019 Outbreak in China. J Clin Med 2020;9. doi:10.3390/jcm9020575.

[13] Chang, Lin M, Wei L, Xie L, Zhu G, Dela Cruz CS, et al. Epidemiologic and Clinical Characteristics of Novel Coronavirus Infections Involving 13 Patients Outside Wuhan, China. JAMA 2020. doi:10.1001/jama.2020.1623.

[14] Li LQ, Huang T, Wang YQ, Wang ZP, Liang Y, Huang TB, et al. 2019 novel coronavirus patients' clinical characteristics, discharge rate and fatality rate of meta-analysis. J Med Virol 2020. doi:10.1002/jmv.25757.

[15] Armitage R, Nellums LB. COVID-19 and the consequences of isolating the elderly. The Lancet. Public health.2020.doi: 10.1016/S2468-2667(20)30061-X.

[16] Xiong Z, Fu L, Zhou H, Liu JK, Wang AM, Huang Y, et al. Construction and evaluation of a novel diagnosis process for 2019-Corona Virus Disease. Zhonghua Yi Xue Za Zhi 2020;100:E019. doi:10.3760/cma.j.cn112137-20200228-00499.

[17] Corman VM, Landt O, Kaiser M, Molenkamp R, Meijer A, Chu D, et al. Detection of 2019 novel coronavirus (2019-nCoV) by real-time RT-PCR. Euro Surveill 2020;25. doi:10.2807/1560-7917.ES.2020.25.3.2000045.

[18] Li Z, Yi Y, Luo X, Xiong N, Liu Y, Li S, et al. Development and Clinical Application of A Rapid IgM-IgG Combined Antibody Test for SARS-CoV-2 Infection Diagnosis. J Med Virol 2020. doi:10.1002/jmv.25727.

Tables

Table 1: Patient Characteristics and Disease Etiologies

Characteristics	Before the outbreak	After the outbreak	*P* value
Total patients	2912	3453	
Age (median, years)	41 (31,61)	47 (33,67)	0.001
Sex, n (%)			0.632
Male	1204 (41.35)	1532 (44.36)	
Female	1708 (58.65)	1921 (55.63)	
Influenza A virus, n (%)	276 (9.47)	67 (1.94)	<0.001
Influenza B virus, n (%)	52 (1.78)	26 (0.75)	<0.001
COVID-19, n (%)	0 (0)	19 (0.55)	<0.001
Critical patients, n (%)	29 (1.00)	38 (1.10)	0.713
Febrile patients, n (%)	2846 (97.73)	2306(66.78)	<0.001
Infectious diseases, n (%)	2304 (79.12)	2543 (73.65)	<0.001
Upper respiratory infection	1699 (58.34)	1931(55.92)	
Pneumonia	154 (5.28)	102(2.95)	
Cardiovascular infection	6 (0.20)	6 (0.17)	
Abdomino-pelvic infection	207 (7.10)	310 (8.98)	
Skin or soft tissue infection	40 (1.37)	55 (1.59)	
Urinary tract infection	77 (2.64)	54(1.56)	
Conjunctivitis	4 (0.14)	4 (0.11)	
Otitis media	2 (0.07)	2 (0.05)	
Central nervous system infection	2 (0.07)	8 (0.23)	
Tuberculosis	4 (0.14)	4(0.11)	
Brucellosis	4 (0.14)	0(0)	
Unknown origin infections	105 (3.60)	67 (1.94)	
Non-infectious diseases, n (%)	57 (1.95)	42 (1.22)	0.876
Hematologic malignancy	7 (0.24)	4(0.11)	
Hyperthyroidism	2 (0.07)	2(0.05)	
Autoimmune disease	48 (1.64)	36(1.04)	
Fever of unknown origin, n (%)	15 (0.51)	8(0.23)	0.091
Other, n (%)	536 (18.42)	860(24.90)	<0.001

Table 2: Transfer from FC to ED before and after the COVID-19 outbreak

Characteristics	Before the outbreak	After the outbreak	*P* value
FC Patients transferred to ED, n (%)	1142 (39.21)	544 (15.75)	<0.001
Age (median, years)	39 (30,59)	46 (32,63)	0.001
Sex, n (%)			0.541
Male	491 (42.99)	243 (44.67)	
Female	651 (57.01)	301 (55.33)	
Patients transferred from FC to ED within 24 hours, n (%)	1083 (94.84)	482 (88.60)	<0.001
Time interval between FC and ED (minutes)	55 (42,74)	203 (81,468)	<0.001

Table 3 Characteristics and Disease Etiologies of Critically Ill Patients

Characteristics	Before the outbreak	After the outbreak	*P* value
Critical patients, n (%)	29(1.00)	38(1.10)	0.713
Age (median, years)	62 (47,76)	63 (47,78)	0.548
Sex, n (%)			0.630
Male	15 (51.72)	22 (57.89)	
Female	14 (48.28)	16 (42.11)	
APACHE II score	16.1±6.67	18.74±6.72	0.116
Diagnoses, n (%)			
Fever	29 (100)	38 (100)	
Septic shock	9(31.03)	12(31.58)	
Pneumonia with respiratory failure	9(31.03)	10(26.31)	
Acute myocardial infarction	2(6.70)	2(5.26)	
Gastrointestinal bleeding	2(6.90)	1(2.63)	
Acute cerebrovascular disease	1(3.45)	4(10.52)	
Intracranial metastasis of lymphoma	0(0)	1(2.63)	
Central nervous system infection	2(6.90)	1(2.63)	
Acute myocarditis	1(3.45)	1(2.63)	
Tachyarrhythmia	2(6.90)	0(0)	
Ruptured iliac aneurysm	1(3.45)	0(0)	
Acute aortic dissection	0(0)	1 (2.63)	
Diffuse alveolar hemorrhage with SLE	0(0)	1(2.63)	
Acute left heart failure	0(0)	2(5.26)	
Acute pulmonary embolism	0(0)	1(2.63)	
Hyperosmolar hyperglycemic state	0(0)	1(2.63)	
Prognosis, n (%)			0.021
Improvement	16 (55.17)	17 (44.74)	
Non-improvement	4 (13.79)	0(0)	
Death	9 (31.03)	21 (55.26)	

SLE=Systemic Lupus Erythematosus

Table 4: Length of Stay in the FC Before and After the COVID-19 outbreak

Characteristics	Before the outbreak	After the outbreak	*P* value
FC total length of stay (minutes)	22 (12,47)	442 (374,636)	<0.001
ED resuscitation room total length of stay (hours)	22 (7,59)	48 (21,96)	<0.001
Treatment times (minutes)	165(95,241)	123 (78,164)	0.072
Supportive treatment times (minutes)	154 (49,215)	72 (34,160)	0.077

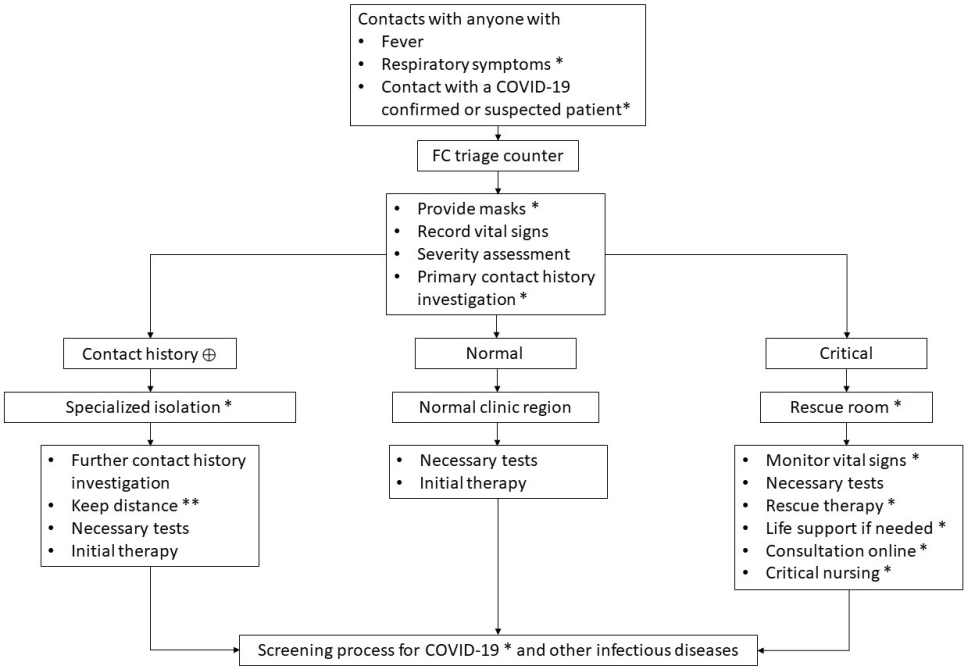
Figure legend

Figure 1 Triage process and regional isolation for different patients in the FC. * Upgraded FC parts. ** Educate patients to maintain a person-to-person distance greater than two meters. Abbreviations: FC: fever clinic, ⊕: positive, COVID-19: coronavirus disease 2019.

Figure 2 Screening process for COVID-19 and other respiratory infectious diseases. * Upgraded FC parts. ** After the COVID-19 outbreak, Chest CT was suggested as a routine examination for patients in FC excluding special populations such as pregnant women and children. *** Patients are recommended to test for SARS-COV-2 RNA again one week later even if previous RNA tests were negative twice if they have: (1) confirmed COVID-19 contact history; (2) clinical manifestations and lab tests implying viral infection which can not be explained by other diseases; (3) chest CT strongly suggestive of viral pneumonia. Abbreviations: , COVID-19: coronavirus disease 2019, ⊕: positive, ⊖: negative, CT: computed tomography, SARS-COV-2: severe acute respiratory syndrome coronavirus 2, NA: nucleic acid, ED: emergency department, IDR: infectious disease report, FC: fever clinic.

Abbreviations:

COVID-19: Corona Virus Disease 2019
SARS-COV-2: Severe Acute Respiratory Syndrome Coronavirus 2
PUMCH: Peking Union Medical College Hospital
ED: Emergency Department
FC: Fever Clinic
CT:Computed Tomography
APACHE II: Acute Physiology and Chronic Health Examination (APACHE) II score
IDR: Infectious Disease Report
NA: Nucleic Acid
SLE:Systemic Lupus Erythematosus
ICU:Intensive Care Unit
PPE: Personal Protective Equipment
DNR: DO NOT RESUSCITATE
PUMCH: Peking Union Medical College Hospital



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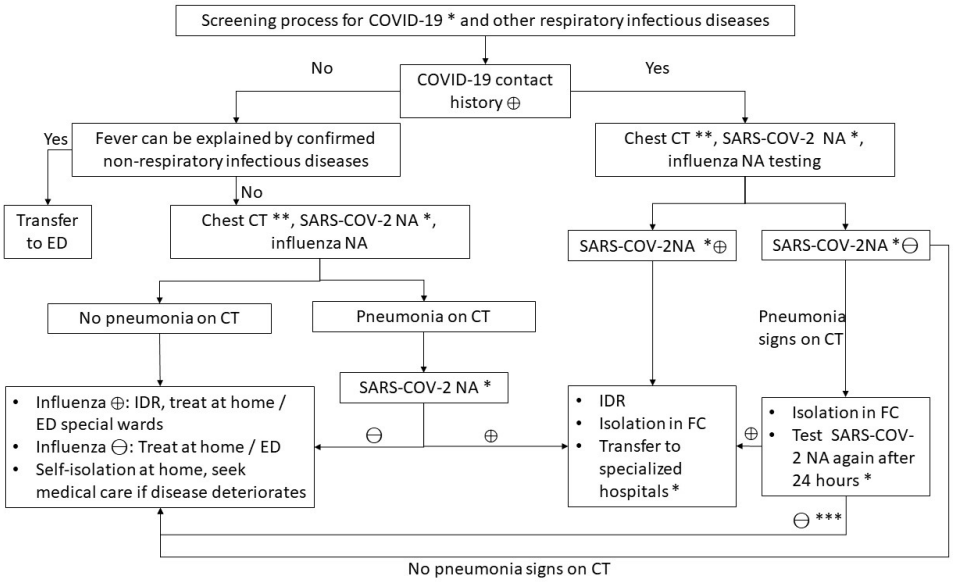

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Journal:	*BMJ Open*
Manuscript ID	bmjopen-2020-039177.R2
Article Type:	Original research
Date Submitted by the Author:	20-Jul-2020
Complete List of Authors:	WANG, JIANGSHAN; Peking Union Medical College Hospital Zong, Liang; Peking Union Medical College Hospital Zhang, Jinghong; School of Medicine, Monash University, Melbourne, Victoria, Australia Sun, Han; Peking Union Medical College Hospital Joseph, Harold; Accident and Emergency Medicine Academic Unit, Prince of Wales Hospital, The Chinese University of Hong Kong, Hong Kong, China Sun, Pengxia; Peking Union Medical College Hospital Xu, Shengyong; Peking Union Medical College Hospital Li, Yan; Peking Union Medical College Hospital Wang, Chunting; Peking Union Medical College Hospital Liu, Jihai; Peking Union Medical College Hospital Li, Fan; Peking Union Medical College Hospital Xu, Jun; Peking Union Medical College Hospital Li, Yi; Peking Union Medical College Hospital Yu, Xuezhong; Peking Union Medical College Hospital Zhu, Huadong; Peking Union Medical College Hospital, emergency
Primary Subject Heading:	Emergency medicine
Secondary Subject Heading:	Infectious diseases, Medical management
Keywords:	HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Health policy < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Public health < INFECTIOUS DISEASES, ACCIDENT & EMERGENCY MEDICINE

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Identifying the Effects of an Upgraded 'Fever Clinic' on COVID-19 control and the Workload of Emergency Department: A Retrospective Study in a Tertiary Hospital in China

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Word count for the text ：3144

Funding：This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Abstract

Objectives: COVID-19 started spreading widely in China in January 2020. Outpatient fever clinics (FC), instituted during the SARS epidemic in 2003, were upgraded to serve for COVID-19 screening and prevention of disease transmission in large tertiary hospitals in China. FC were hoped to relieve some of the healthcare burden from the Emergency Departments (ED). We aimed to evaluate the effect of upgrading the FC system on rates of nosocomial COVID-19 infection and ED patient attendance at Peking Union Medical College Hospital（PUMCH）.

Design: A retrospective cohort study.

Participants: A total of 6,365 patients were screened in the FC.

Methods: The FC of PUMCH was upgraded on January 20, 2020. We performed a retrospective study of patients presenting to the FC between December 12, 2019 and February 29, 2020. January 20, 2020 was the date when COVID-19 was declared an outbreak in Beijing. Two groups of data were collected and subsequently compared with each other: The first group of data was collected within 40 days before January 20, 2020; The second group of data was collected within 40 days after January 20, 2020. All necessary data, including patient baseline information, diagnosis, follow-up conditions, and the transfer records between the FC and ED were collected and analyzed.

Results: 6,365 patients were screened in the FC, among whom 2,912 patients were screened before January 21, 2020, while 3,453 were screened afterward. Screening results showed that upper respiratory infection was the major disease associated with fever. After the outbreak of COVID-19, the number of patients who were transferred from the FC to ED decreased significantly [39.21% vs 15.75%, p<0.001], and patients generally spent more time in the FC [55 vs 203minutes, p<0.001], compared with before the outbreak. For critically ill patients waiting for their screening results, the total length of stay in the FC was 22minutes before the outbreak, compared with 442minutes after the outbreak (p< 0.001). The number of in-hospital deaths of critically ill patients in the FC was 9 out of 29 patients before the outbreak and 21 out of 38 after the outbreak (p<0.05). 19 cases of COVID-19 were confirmed in the FC during the period of this study. However, no other patients nor any healthcare providers were cross-infected.

Conclusion: The workload of the FC increased significantly after the COVID-19 outbreak. New protocols regarding the use of FC likely helped prevent the spread of COVID-19 within the hospital. The upgraded FC also reduced the burden on the ED.

Keywords: COVID-19 outbreak, fever clinic, emergency department, effective screening, disease

prevention

Strengths and limitations of this study

- This study identified the roles of fever clinic and its functional association with the emergency department during COVID-19 pandemic.
- A reasonably large sample size was included over the duration of this study.
- The findings of this study can serve as valuable references for hospitals worldwide, in the battle of COVID-19.
- Our analysis was limited in a single tertiary hospital in Beijing. Comparing the data from this study with the data from other local hospitals would further validate this study.

Introduction

Background

The 2019 novel coronavirus disease (COVID-19) caused by the severe acute respiratory syndrome coronavirus 2 (SARS-COV-2) broke out in Wuhan, China at the end of 2019[1]. The number of confirmed cases has rapidly increased since then on a global scale [2] . The control of the spread of SARS-CoV-2 is of the primary concern[3] at this stage. The main manifestation of COVID-19 includes acute fever, cough and dyspnea[4], therefore the emergency department (ED) has become the primary facility that provides initial diagnosis and treatment for potential COVID-19 patients. Due to the large number of patients presenting to ED every day, the likelihood of cross-infection and the spread of COVID-19 within the hospital is very likely to occur[5,6]. In mainland China, the 'fever clinic' (FC) is a separate unit that is affiliated to the ED, specializing in the screening of infectious diseases. They have been designed to protect patients in the ED from those who have contracted infectious diseases[7]. The implementation of the FC system was originally suggested by the National Health Commission of the People's Republic of China during the SARS epidemic in 2003[8]. As a result of the successful implementation of the FC system, suspected patients with infectious diseases are not managed first inside the Chinese ED[9]. However, after the SARS era, the importance of the FC system in terms of infection control within the hospital has been largely neglected.

Fever Clinic upgrade post COVID-19 outbreak

Before the COVID-19 outbreak, 4 doctors were allocated to the FC of PUMCH where influenza A and B were routinely screened for patients presenting with fever and respiratory symptoms. The FC was also tasked with excluding eruptive infectious diseases (e.g. measles, rubella, and varicella). Patients with such potential infectious diseases received their initial treatment in the FC; some of them were subsequently transferred to inpatient isolation wards while others were transferred to the ED for further evaluation and monitoring. After the COVID-19 outbreak, 12 doctors worked in the FC equipped with 'Grade-3' personal protective equipments (PPE)[10], including a disposable medical-grade protective suit, an isolation gown, a N95 filtering facepiece respirator, goggles, a disposable full-face shield, two layers of clean gloves and boot covers. Two consulting rooms were added to supplement the original single room. The number of medical care providers providing

in-person coverage increased from 2 to 9, while the number of nursing staff increased from 9 to 15 pere 24 hours. Resuscitation equipments, such as endotracheal intubation tools, central venous catheters, noninvasive and invasive ventilator machines, high-flow oxygen therapy devices and bedside ultrasound, were prepared for use.

All patients with either fever or respiratory symptoms, regardless of a history of COVID-19 exposure, were instructed to go through the FC triage (Figure 1). Each patient was required to wear a mask on arrival to the FC and was allocated to different regions according to their triage history and clinical severity (Figure 1). The FC took responsibility for screening SARS-COV-2, in addition to influenza and eruptive infectious diseases. All acquired nucleic acid samples were tested by two independent laboratories licensed by the Beijing Municipal Health Commission for SARS-COV-2 testing. The screening result was only accepted as negative if SARS-COV-2 was not identified by both laboratories. Doctors in the FC were divided into three separate groups that oversaw suspected patients, critical patients and regular patients, respectively. Negative pressure isolation wards with complete sets of resuscitation equipment were readily available for any critical patients. As soon as the screening tests were reported, patients with confirmed SARS-COV-2 would be immediately transferred to other hospitals that were designated for COVID-19 patients, whereas other patients who needed further treatment were subsequently transferred into the ED (Figure 2).

Methods

Data collection

We collected data from all patients presenting to the FC of PUMCH in the last 40 days before the FC upgrade (from December 12, 2019 to January 20, 2020), and for another 40 days after FC upgrade (from January 21 to February 29, 2020). The FC was upgraded on January 20, 2020 which was also the official date when COVID-19 was declared an "outbreak" in Beijing. We included all critically ill patients during the period of this study, who initially presented to the FC and subsequently transferred to the ED The data were collected from patients' medical records and their registration information. Clinical manifestation, primary diagnosis, time of registration, and the duration of each consultation were documented for all patients involved in the study.

Critically ill patients were included based on the following criteria: (1) patients who were transferred to the resuscitation room in the ED after initial screening and treatment at the FC; (2) APACHE II score ≥8; (3) patients who tested negative for COVID-19[11]. Critically ill patients' prognosis and treatment results were documented in their medical records. Changes in patients' condition (e.g. improvement, deterioration or death) within seven days after their initial presentation at the FC were also recorded.

Patient and Public Involvement:

This was a retrospective study, we collected the medical information of all involved patients from the electronic information system. Patients were not involved in the recruitment for any additional trials or any particular study designs.

Statistics

Statistical Package for Social Sciences 24.0 software (IBM Corp., Aramonk, NY, USA) was used for statistical analysis. The Kolmogorov-Smirnov test was used to determine the normal distribution of variables. Variables with normal distribution are shown as a mean (±SD). T-tests were used for variables that followed normal distribution. Data that did not follow normal distribution was shown as a median (25%-75%) and analyzed by the Wilcoxon rank-sum test. Chi-square tests and Fisher's exact tests were used for enumeration data. P-value less than 0.05 were taken to indicate statistical significance.

Results

Patient Characteristics and Disease Etiologies

In total, 6,365 patients were screened in the FC, among whom 2,912 patients were screened before the outbreak, and 3,453 patients were screened after the outbreak. There was no statistical difference between the two groups for sex, but a significant difference in age was found (p=0.001). The most common diseases found in the FC were an upper respiratory infections, followed by abdomino-pelvic infections and pneumonias (Table 1). From January 24 to February 11, 19 patients were diagnosed with COVID-19 at the FC. All COVID-19 patients diagnosed in the FC during the study period had mild to moderate symptoms, and therefore there were no critical cases involving COVID-19 in this study. It is worth mentioning that all patients and medical staff who were in contact with COVID-19 patients were strictly followed-up for 14 days, and no cases of cross-infection were discovered.

Patient transfer from the Fever Clinic to Emergency Department

The number of patients who initially presented to the FC and subsequently transferred to the ED before the outbreak was 1,142, in contrast to 544 after the outbreak. There was no statistical difference in the sex ratio or age of patients between the two groups (p>0.05). Before the outbreak, 1,083 cases (94.8%) of transfer completed in 24 hours. However, significantly fewer (482 cases, 88.60%) were transferred to the ED within 24 hours (p<0.001) after the outbreak. In addition, patients received a significantly longer duration of treatment in the FC after the outbreak (p<0.001) (Table 2).

Critically ill patients

69 critically ill patients were initially identified in our study. 2 patients were subsequently excluded due to an APACHE II score less than 8 points. Among the remaining 67 patients, 29 visited the FC before the outbreak while 38 presented after the outbreak. The ratio of male to the female patients was 1.23:1 and their median age was 63 (47,78) years. There was no significant difference in sex ratio or the age of patients between the two groups (p>0.05). There was also no significant difference in the severity of disease between the two groups when examining their respective APACHE II scores (16.1±6.67 vs 18.74±6.72). Patients with septic shock and pneumonia combined with respiratory failure accounted for most diagnosis. The number of in-hospital deaths within seven days among critically ill patients seen in the FC was 9 out of 29 before the outbreak, and 21

out of 38 after the outbreak (p<0.05) (Table 3).

Length of stay in the Fever Clinic and Emergency Department

The total length of stay in the FC was 22 (12,47) minutes before the outbreak, compared with 442 (374,636) minutes after the outbreak (p<0.001). In addition, the total length of stay in the resuscitation room of the ED lengthened from 22 (7,59) hours to 48 (21,96) hours (p<0.001) (Table 4).

The most commonly provided types of treatment in the FC were: antibiotics, antiarrhythmic, antihypertensives and antiplatelet medications. Common supportive treatments included nasal catheter oxygen, non-invasive/invasive ventilation, fluid resuscitation, vasopressors, intracranial pressure-lowering medications and diuretic medications. The initial treatment times are shown in Table 4.

Discussion

COVID-19 is a novel infectious disease of the respiratory system. It has become a notifiable infectious disease since January 20, 2020 according to the National Health Commission of the People's Republic of China. From January 20, the Beijing Municipal Government initiated a level-1 (highest) public health response to prevent the spread of COVID-19[12]. The fever clinic of PUMCH was upgraded in response to the disease outbreak. In this study, we analyzed the recorded patient data taken from the FC in the 40 days pre- and post-COVID-19 outbreak. We found that after the outbreak, the FC had played a more important role in delivering treatment to critically ill patients. Therefore, those patients were able to receive their initial management in the FC rather than in the ED. Some patients were subsequently transferred to the ED for further treatment if they had been tested negative for SARS-COV-2 by two different laboratories. As a result, no COVID-19 cases were transferred or identified in the ED during 40 days of the post-outbreak period. More surprisingly, no patients, doctors or nurses in other departments of the hospital were cross-infected with COVID-19. Therefore, this FC upgrade strategy is strongly suggested to have contributed to the successful prevention of the spread of COVID-19 within the hospital.

According to our data, upper respiratory infections were most commonly seen in the FC both before and after the COVID-19 outbreak. Most mild COVID-19 patients had upper respiratory infection syndromes [13] , these patients were also strongly infectious and posed a substantial screening challenge. It was not possible to exclude COVID-19 merely based on clinical symptoms alone [14]. The average age of patients tended to be older after the outbreak [15]. A reasonable explanation for this was that patients with relatively severe diseases had to seek medical care in hospitals even though they faced a high risk of cross-infection with COVID-19. Older people generally have a higher risk of developing severe diseases, but the difference in age between the two groups did not exist in critically ill patients in our study, which could be attributed to the fact that most critically ill patients were older.

Every patient staying in the FC was considered as a potential source of infection, and preventing

the spread of potentially contagious diseases to the rest of the ED and hospital was a key mission of the FC. Before the outbreak, the major work of the FC was to identify influenza, which would usually take only 30 minutes. Once a patient was confirmed to not have influenza, they would be allowed to be transferred to the ED with limited precautions. However, after the COVID-19 outbreak, data showed that there was a decrease in the number of transfer patients from the FC to the ED in order to reduce the likelihood of overcrowding the ED. Less crowding in the ED also likely lessened the chances of cross-infection. Traditionally, the FC was tasked with screening and providing initial supportive treatment to patients. After the outbreak, the FC needed to perform an additional task by offering more comprehensive treatment. For FC patients who needed further medical management in the ED, they could only be transferred until being tested negative for SARS-COV-2. Patients and medical staff in the ED were protected from contracting COVID-19 by the FC, but the FC had to expand to support patients during the "rule-out" phase of testing.

Intensive screening also played an important role in COVID-19 testing. Before the outbreak, having a fever was the only screening indicator for all patients. Unfortunately, 11.5% of COVID-19 patients do not present with fever, while 82.4% of patients develop respiratory symptoms, such as cough, expectoration and dyspnea[12]. This led to a modification of the FC inclusion criteria to now include: (1) patients with a positive COVID-19 contact exposure; (2) patients presenting with fever;(3) patients with respiratory symptoms. With the new criteria in place, the number of FC patients grew dramatically in the 40 days after January 20, 2020.

Multiple testing methods were trialed to decrease false-negative rates. As COVID-19 showed diverse manifestations, it was unreliable to identify this disease based on only one method. In our screening process, multiple methods, including blood cell analysis, chest CT[16], SARS-COV-2 nucleic acid[17] and antibody tests[18] were used to screen for this disease. However, each method had its own false-negative risks, therefore all patients suspected of any viral infection were recommended to receive a further nucleic acid test 24 hours after the first test. This method helped assure that FC patients who were subsequently transferred to the ED possessed a minimal risk of spreading COVID-19 in the hospital. In addition, to avoid false-negative results, patients with the following conditions were recommended for repeat SARS-COV-2 nucleic acid testing again after one week: (1) confirmed COVID-19 contact history; (2) clinical manifestations and lab testing suggesting a viral infection that is unexplained by another disease; (3) chest CT indicates viral pneumonia, despite previous negative nucleic acid testing. With these strict screening criteria imposed, no COVID-19 cases were diagnosed among patients in the ED during the period of this study.

An effective triage strategy also reduced the risk of cross-infection. As the number of FC patients increased rapidly, the prevention of cross-infection become a major concern. According to patients' COVID-19 contact history and clinical severity, they were allocated to one of three specialized sections of the FC. One of the sections was designated for patients who had a positive contact history. Such patients were quarantined in this section pending negative SARS-COV-2 testing while keeping a person-to-person distance of at least two meters. For the second section, critically ill patients identified at triage counter were quickly brought to resuscitation rooms in the FC, where experienced physicians would provide further assessment. Once negative results were

reported for SARS-COV-2, they were transferred to the ED resuscitation rooms. For patients deemed least likely to have COVID-19 who did not require resuscitation, they would receive their treatment in the third section, where they would see a doctor and start SARS-COV-2 testing.

After the COVID-19 outbreak, PPE worn by healthcare workers in the FC was upgraded to a higher infection-control standard. All consulting rooms and observation rooms were negative-pressure rooms. Each consulting room was sterilized by ultraviolet light for one hour every day, and by alcohol (75%) spray on all the surfaces (e.g. desks, computers, keyboards and printers) once every four hours. Negative-pressure airborne infection isolation observation rooms were also sterilized by ultraviolet light for one hour every day even when no patients were admitted. When a patient left an observation room, ultraviolet light sterilization and alcohol spray for surfaces was performed immediately.

This study showed that the seven-day mortality rate for critically ill patients was 55.26% (21/38) after the outbreak. In contrast, the mortality was 31.03% (9/29) before the outbreak. There are likely several reasons underlying this difference in mortality . First, the sample size was small in both groups, thus creating sampling error. Second, 2 patients from the 9/29 group and 7 patients from the 21/38 group actually carried “Do Not Resuscitate” (DNR) orders. If these DNR patients were excluded from their respective study groups, the mortality rates would narrow to 24.13% (7/29) in the first group (before the outbreak) and 36.84% (14/38) in the second group (after the outbreak). Third, a new policy at PUMCH during the COVID-19 outbreak stated that critically ill patients from the ED could not be quickly admitted into the Intensive Care Unit (ICU) and other specialist wards, in order to prevent the spread of COVID-19 in the hospital. This resulted in a longer duration of stay in the ED, likely negatively affecting the overall prognosis of critically ill patients, regardless of FC stay.

Strengths and limitations

This study had several limitations. It was a retrospective study at a single center and carried the associated weaknesses of such study methodologies. Nevertheless, given the seriousness of the global battle against COVID-19, the findings related to FC upgrades and the coordination between FC and ED are potentially important and valuable. Future studies would benefit from examining the effects of integrating FC with other parts of the hospital to encourage even more efficient screening and infection prevention pathways.

Conclusion

This retrospective study demonstrated the effect of changes implemented in the FC system in response to the COVID-19 outbreak. All modifications to the FC were designed to improve the efficiency of triage and lower the risk of spreading COVID-19 to the ED and other parts of the hospital. The upgraded FC also was able to lessen the burden on the ED by providing more extensive treatment for patients than in the past. Although further studies are needed to examine

the best role of the FC in fighting COVID-19, this study detailed how the FC system can play a significant role in preventing the spread of COVID-19 in a large, tertiary teaching hospital. By implementing an effective FC system that works in parallel with the ED, hospitals may provide efficacious patient management while protecting the rest of the hospital.

Declarations

Ethics approval and consent to participate

This study was approved by the ethics committee of the Peking Union Medical College Hospital (Ref S-K1091).

All of the data used in this study were anonymized before its use.

Written informed consent of participants.was not applicable

Data availability statement Extra data can be accessed via the Dryad data repository at http://datadryad.org/ with the doi: 10.5061/dryad.rjdfn2z84

Conflicts of interest: We declare no conflicts of interest.

Author contributions: JSW and JHL were responsible for the conception and design of the study.JSW, HS, PXS, SYX, YL(Yan Li), JX, and CTW contributed to the literature search and data collection, LZ and FL oversaw the statistical analysis and data interpretation.LZ, JSW and JHZ took part in drafting the manuscript. JHW, XZY, YL(Yi Li)and HDZ revised and approved the final version of the manuscript. All authors read and approved the final submitted version. The corresponding authors attest that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

Acknowledgments

We would like to thank all the healthcare providers working in the fever clinic and emergency department of PUMCH during the COVID-19 pandemic for their dedication and professionalism during this challenging time.

References

[1] Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, et al. A Novel Coronavirus from Patients with Pneumonia in China, 2019. N Engl J Med 2020;382:727-33. doi:10.1056/NEJMoa2001017.

[2] World Health Organization. Coronavirus disease (COVID-2019) situation report #68. March 28, 2020 Available online: https://www.who.int/docs/default- source/coronaviruse/situation-reports/20200328-sitrep-68-covid-19.pdf?sfvrsn=384bc74c_2. Accessed March 29, 2020.

[3] Lai CC, Shih TP, Ko WC, Tang HJ, Hsueh PR. Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and coronavirus disease-2019 (COVID-19): The epidemic and the challenges. Int J Antimicrob Agents 2020;55:105924. doi:10.1016/j.ijantimicag.2020.105924.

[4] Guan WJ, Ni ZY, Hu Y, Liang WH, Ou CQ, He JX , et al. Clinical Characteristics of Coronavirus Disease 2019 in China. N Engl J Med.2020. doi: 10.1056/NEJMoa2002032.

[5] COVID-19: protecting health-care workers. The Lancet. 2020. DOI:https://doi.org/10.1016/S0140-6736(20)30644-9.

[6] Webster P.Canada and COVID-19: learning from SARS. The Lancet. 2020;395(10228):936-937.

[7] Hu Z, Song C, Xu C, Jin G, Chen Y, Xu X,et al. Clinical characteristics of 24 asymptomatic infections with COVID-19 screened among close contacts in Nanjing, China. 2020. doi: 10.1007/s11427-020-1661-4.

[8] Amrane S, Tissot-Dupont H, Doudier B, Eldin C, Hocquart M, Mailhe M, et al.Rapid viral diagnosis and ambulatory management of suspected COVID-19 cases presenting at the infectious diseases referral hospital in Marseille, France, - January 31st to March 1st, 2020: A respiratory virus snapshot. Travel Med Infect Dis. 2020.doi: 10.1016/j.tmaid.2020.101632.

[9] Zhang MQ, Wang XH, Chen YL, Zhao KL, Cai YQ, An CL, et al.Clinical features of 2019 novel coronavirus pneumonia in the early stage from a fever clinic in Beijing. Chinese Journal of tuberculosis and respiratory diseases. 2020 ,43(3):215-218.

[10] National Health Commission of the People's Republic of China. Technical guidelines for the protection to health care provider during the 2019 Coronavirus Disease (COVID-19) epidemic. Jan 23, 2020. Available online: http://www.nhc.gov.cn/yzygj/s7659/202001/b91fdab7c304431eb082d67847d27e14.shtml. Accessed March 12, 2020.

[11] National Health Commission of the People's Republic of China. Diagnosis and treatment of novel coronavirus pneumonia. (7th trial version). March 4, 2020. Available online: http://www.nhc.gov.cn/yzygj/s7653p/202003/46c9294a7dfe4cef80dc7f5912eb1989/files/ce3e6945832a438eaae415350a8ce964.pdf.Accessed March 15, 2020

[12] Deng SQ, Peng HJ. Characteristics of and Public Health Responses to the Coronavirus Disease 2019 Outbreak in China. J Clin Med 2020;9. doi:10.3390/jcm9020575.

[13] Chang, Lin M, Wei L, Xie L, Zhu G, Dela Cruz CS, et al. Epidemiologic and Clinical Characteristics of Novel Coronavirus Infections Involving 13 Patients Outside Wuhan, China. JAMA 2020. doi:10.1001/jama.2020.1623.

[14] Li LQ, Huang T, Wang YQ, Wang ZP, Liang Y, Huang TB, et al. 2019 novel coronavirus patients' clinical characteristics, discharge rate and fatality rate of meta-analysis. J Med Virol 2020.

doi:10.1002/jmv.25757.

[15] Armitage R, Nellums LB. COVID-19 and the consequences of isolating the elderly. The Lancet. Public health.2020.doi: 10.1016/S2468-2667(20)30061-X.

[16] Xiong Z, Fu L, Zhou H, Liu JK, Wang AM, Huang Y, et al. Construction and evaluation of a novel diagnosis process for 2019-Corona Virus Disease. Zhonghua Yi Xue Za Zhi 2020;100:E019. doi:10.3760/cma.j.cn112137-20200228-00499.

[17] Corman VM, Landt O, Kaiser M, Molenkamp R, Meijer A, Chu D, et al. Detection of 2019 novel coronavirus (2019-nCoV) by real-time RT-PCR. Euro Surveill 2020;25. doi:10.2807/1560-7917.ES.2020.25.3.2000045.

[18] Li Z, Yi Y, Luo X, Xiong N, Liu Y, Li S, et al. Development and Clinical Application of A Rapid IgM-IgG Combined Antibody Test for SARS-CoV-2 Infection Diagnosis. J Med Virol 2020. doi:10.1002/jmv.25727.

Tables

Characteristics	Before the outbreak	After the outbreak	*P* value
Total patients	2912	3453	
Age (median, years)	41 (31,61)	47 (33,67)	0.001
Sex, n (%)			0.632
Male	1204 (41.35)	1532 (44.36)	
Female	1708 (58.65)	1921 (55.63)	
Influenza A virus, n (%)	276 (9.47)	67 (1.94)	<0.001
Influenza B virus, n (%)	52 (1.78)	26 (0.75)	<0.001
COVID-19, n (%)	0 (0)	19 (0.55)	<0.001
Critical patients, n (%)	29 (1.00)	38 (1.10)	0.713
Febrile patients, n (%)	2846 (97.73)	2306(66.78)	<0.001
Infectious diseases, n (%)	2304 (79.12)	2543 (73.65)	<0.001
Upper respiratory infection	1699 (58.34)	1931(55.92)	
Pneumonia	154 (5.28)	102(2.95)	
Cardiovascular infection	6 (0.20)	6 (0.17)	
Abdomino-pelvic infection	207 (7.10)	310 (8.98)	
Skin or soft tissue infection	40 (1.37)	55 (1.59)	
Urinary tract infection	77 (2.64)	54(1.56)	
Conjunctivitis	4 (0.14)	4 (0.11)	
Otitis media	2 (0.07)	2 (0.05)	
Central nervous system infection	2 (0.07)	8 (0.23)	
Tuberculosis	4 (0.14)	4(0.11)	
Brucellosis	4 (0.14)	0(0)	
Unknown origin infections	105 (3.60)	67 (1.94)	
Non-infectious diseases, n (%)	57 (1.95)	42 (1.22)	0.876
Hematologic malignancy	7 (0.24)	4(0.11)	
Hyperthyroidism	2 (0.07)	2(0.05)	
Autoimmune disease	48 (1.64)	36(1.04)	
Fever of unknown origin, n (%)	15 (0.51)	8(0.23)	0.091
Other, n (%)	536 (18.42)	860(24.90)	<0.001

Table 1: Patient Characteristics and Disease Etiologies

Table 2: Patient transfer from the Fever Clinic to Emergency Department

Characteristics	Before the outbreak	After the outbreak	*P* value
FC Patients transferred to ED, n (%)	1142 (39.21)	544 (15.75)	<0.001
Age (median, years)	39 (30,59)	46 (32,63)	0.001
Sex, n (%)			0.541
Male	491 (42.99)	243 (44.67)	
Female	651 (57.01)	301 (55.33)	
Patients transferred from FC to ED within 24 hours, n (%)	1083 (94.84)	482 (88.60)	<0.001
Time interval between FC and ED (minutes)	55 (42,74)	203 (81,468)	<0.001

Table 3 Characteristics and Disease Etiologies of Critically Ill Patients

Characteristics	Before the outbreak	After the outbreak	*P* value
Critical patients, n (%)	29(1.00)	38(1.10)	0.713
Age (median, years)	62 (47,76)	63 (47,78)	0.548
Sex, n (%)			0.630
Male	15 (51.72)	22 (57.89)	
Female	14 (48.28)	16 (42.11)	
APACHE II score	16.1±6.67	18.74±6.72	0.116
Diagnosis, n (%)			
Fever	29 (100)	38 (100)	
Septic shock	9(31.03)	12(31.58)	
Pneumonia with respiratory failure	9(31.03)	10(26.31)	
Acute myocardial infarction	2(6.70)	2(5.26)	
Gastrointestinal bleeding	2(6.90)	1(2.63)	
Acute cerebrovascular disease	1(3.45)	4(10.52)	
Intracranial metastasis of lymphoma	0(0)	1(2.63)	
Central nervous system infection	2(6.90)	1(2.63)	
Acute myocarditis	1(3.45)	1(2.63)	
Tachyarrhythmia	2(6.90)	0(0)	
Ruptured iliac aneurysm	1(3.45)	0(0)	
Acute aortic dissection	0(0)	1 (2.63)	
Diffuse alveolar hemorrhage with SLE	0(0)	1(2.63)	
Acute left heart failure	0(0)	2(5.26)	
Acute pulmonary embolism	0(0)	1(2.63)	
Hyperosmolar hyperglycemic state	0(0)	1(2.63)	
Prognosis, n (%)			0.021
Improvement	16 (55.17)	17 (44.74)	
Non-improvement	4 (13.79)	0(0)	
Death	9 (31.03)	21 (55.26)	

SLE=Systemic Lupus Erythematosus

Table 4: Length of stay in the Fever Clinic and Emergency Department

Characteristics	Before the outbreak	After the outbreak	*P* value
FC total length of stay (minutes)	22 (12,47)	442 (374,636)	<0.001
ED resuscitation room total length of stay (hours)	22 (7,59)	48 (21,96)	<0.001
Treatment times (minutes)	165(95,241)	123 (78,164)	0.072
Supportive treatment times (minutes)	154 (49,215)	72 (34,160)	0.077

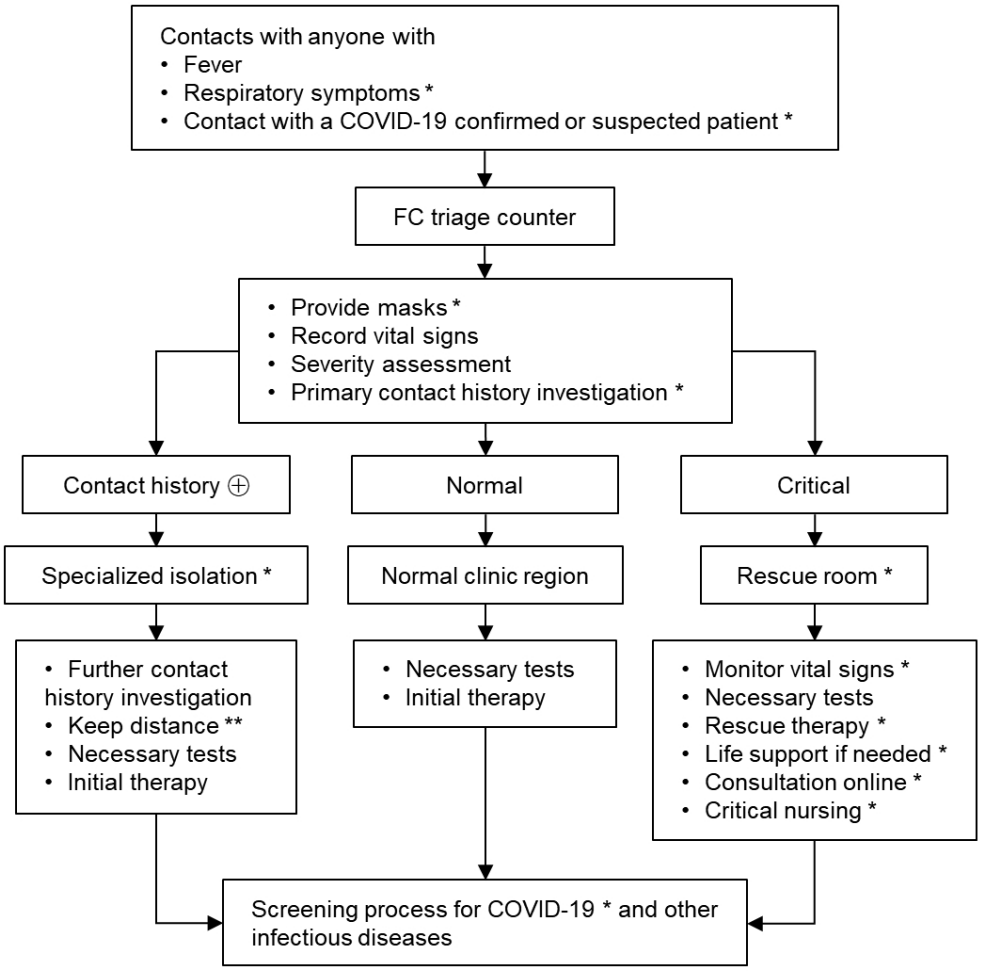
Figure legend

Figure 1 Triage process and regional isolation for different patients in the FC. * Upgraded FC parts. ** Educate patients to maintain a person-to-person distance greater than two meters. Abbreviations: FC: fever clinic, ⊕: positive, COVID-19: coronavirus disease 2019.

Figure 2 Screening process for COVID-19 and other respiratory infectious diseases. * Upgraded FC parts. ** After the COVID-19 outbreak, Chest CT was suggested as a routine examination for patients in FC excluding special populations such as pregnant women and children. *** Patients are recommended to test for SARS-COV-2 RNA again one week later even if previous RNA tests were negative twice if they have: (1) confirmed COVID-19 contact history; (2) clinical manifestations and lab tests implying viral infection which can not be explained by other diseases; (3) chest CT strongly suggestive of viral pneumonia. Abbreviations: , COVID-19: coronavirus disease 2019, ⊕: positive, ⊖: negative, CT: computed tomography, SARS-COV-2: severe acute respiratory syndrome coronavirus 2, NA: nucleic acid, ED: emergency department, IDR: infectious disease report, FC: fever clinic.

Abbreviations:

COVID-19: Corona Virus Disease 2019
SARS-COV-2: Severe Acute Respiratory Syndrome Coronavirus 2
PUMCH: Peking Union Medical College Hospital
ED: Emergency Department
FC: Fever Clinic
CT: Computed Tomography
APACHE II: Acute Physiology and Chronic Health Examination (APACHE) II score
IDR: Infectious Disease Report
NA: Nucleic Acid
SLE: Systemic Lupus Erythematosus
ICU: Intensive Care Unit
PPE: Personal Protective Equipment
DNR: Do Not Resuscitate [order]



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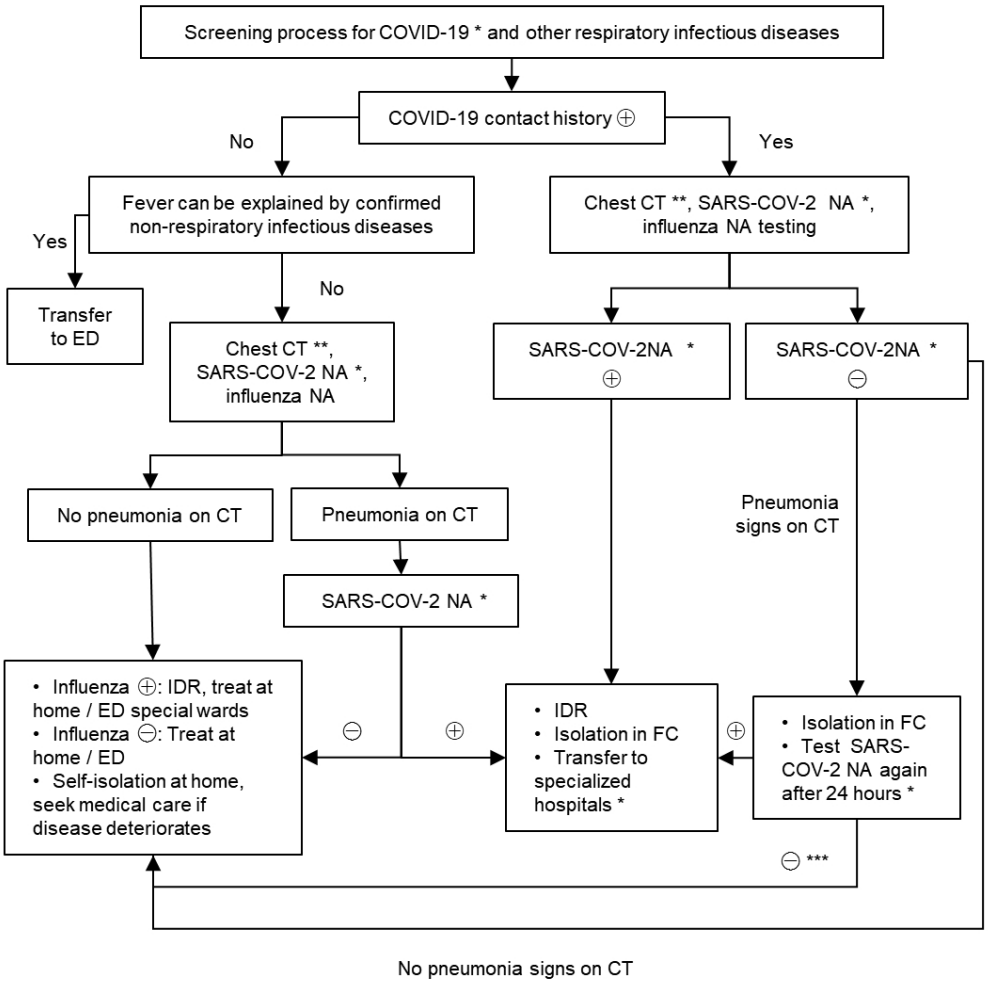

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	Item No.	Recommendation	Page No.	Relevant text from manuscript
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1	A retrospective cohort study
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2	Abstract
Introduction				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3	Introduction-Background
Objectives	3	State specific objectives, including any prespecified hypotheses	2	Abstract-Objectives
Methods				
Study design	4	Present key elements of study design early in the paper	4	Methods
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4	Methods-Data collection
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	4	Methods-Data collection
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed		
Variable	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4	Methods
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	4	Methods-Statistics
Bias	9	Describe any efforts to address potential sources of bias	8	Strengths and limitations
Study size	10	Explain how the study size was arrived at	4	Methods-Data collection
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	4	Methods-Data collection
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	4-5	Methods-Statistics Results-Critically ill patients
		(*b*) Describe any methods used to examine subgroups and interactions		

		(*c*) Explain how missing data were addressed		
		(*d*) If applicable, explain how loss to follow-up was addressed		
Results				
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5	Results-Patient Characteristics and disease aetiologies Results-Critically ill patients
		(b) Give reasons for non-participation at each stage		
		(c) Consider use of a flow diagram		
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	5	Results-Patient Characteristics and disease aetiologies Results-Critically ill patients
		(b) Indicate number of participants with missing data for each variable of interest		
		(c) Summarise follow-up time (eg, average and total amount)		
Outcome data	15*	Report numbers of outcome events or summary measures over time	5	Results
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	5-6	Results
		(*b*) Report category boundaries when continuous variables were categorized		
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period		
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	5	Results
Discussion				
Key results	18	Summarise key results with reference to study objectives	8-9	Discussion-Key results
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	8	Strengths and limitations

Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	6-8	Discussion-Interpretation/Conclusion
Generalisability	21	Discuss the generalisability (external validity) of the study results	8	Discussion-Interpretation/Conclusion
Other information				
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	1	Cover page